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The Progress of Electric Welding. MR. HERMANN LEMP'S paper, published on another page, is a record of achievement such as is seldom made. Swift as is the progress of electrical industries, the art of welding has apparently out-stripped them all in rapidity of development. Materials are now electrically welded that before could scarcely be soldered, much less united more intimately. Mr. Lemp's description of the methods and apparatus used in the process are of great interest, and the experimental demonstrations that accompanied it were an evidence of the beautiful automatism of the machines used.

Bargain-Counter Telegraphy. THE postal telegraph scheme is dying of inanition. We cannot say that its timely decease will be regretted by a host of sorrowing friends, for it had but few, and the only tears they will shed will be of the crocodile variety. Nor will its grave be decked with flowers, save possibly those of sulphur. A straggling telegraph service with slow delivery and operators changed with every change of administration fills no long-felt public want and has no reasonable excuse for cumbering the earth. The question of government control of all lines is perhaps open for discussion on its merits or demerits, but no exaggerated automatic cash systems need apply.

Continuous Current Transformers. A REPORT comes this week that our English friends have installed a continuous current transformer for public service. If they have at last captured that particularly exasperating electrical Will o'-the-Wisp, and confined it at hard labor, they are, indeed, to be congratulated. Continuous currents do not take kindly to being transformed, and most of the efforts in that direction have met with little success. There are certain cases, however, where the method may well be employed. It is highly probable that a three-wire central station operated by motors supplied with current from a distant water power would show a commercial efficiency quite as high as an alternating system of distribution worked from the same point.

Storage Batteries for Traction. MR. RECKENZAUN'S study of traction by storage batteries is well worth the attention of electricians. He speaks as one having authority, having devoted a large part of his time for some years to working out the practical application of the storage battery to city electric traction. His figures are the result of a large amount of careful and exact experimentation, and show admirably the present state of the art. Although most of the electric railway service in this country is conducted on the overhead system, the use of other means of supply sometimes becomes necessary in the case of large cities, and studies like that of Mr. Reckenzaun are valuable in determining the practical applications necessary to the different service required.

An Electric Torch. IF the report from England which we publish elsewhere be correct, the Saunderson arc lamp possesses some very valuable properties. The principle on which the invention is based is that of reinforcing the luminous particles of incandescent carbon in the electric arc by a supply of hydrocarbon vapor. This is fed directly into the arc from the hollow lower carbon, fitted with a reservoir of oil and a wick. The effect of the added volume of vapor is said to be an enormous increase in the luminosity of the arc, and, consequently, a most brilliant and economical light. The hydrocarbon employed is very cheap, and the hollow carbon entails a very slight extra expense; but the efficiency of the arc in watts per candle is said to be nearly doubled. The color of the arc is changed by the enriching medium to a clear yellowish white, quite different from the usual bluish glare. The invention is certainly very ingenious, and if the results are uniformly as good as those found by Dr. Hopkinson, who conducted the tests quoted, we may expect before long to see the new electric torch in general use.

Setting up Clark Cells. THE Clark cell has for some years been recognized as our best standard of reference for electromotive forces, as it possesses remarkable constancy when not exposed to short circuits. It is, however, not easy to set up or use except in a laboratory, as the forms heretofore most generally employed require the purest of chemicals and extraordinary precautions in manufacture, and are easily injured in transportation. Mr. Fessenden, in his paper published this week, gives full working directions for making these cells by a comparatively simple method. By the device of electro-deposition the metallic zinc is secured in a pure state, while the precautions to be taken with the other elements of the battery are described in detail, and the resulting form of cell is very neat. Cells made according to this method have been found by Mr. Fessenden to have the same electromotive force and constancy as those prepared by more elaborate processes. The manufacture of Clark elements in this way is shortly to be taken up, and it is to be hoped that the result will be a wide distribution of this most valuable standard among electricians.

Electrical Progress. OUR enterprising contemporary *L'elettricita*, of Milan, requested some months ago the opinion of the electrical fraternity on the progress of the art. Two questions were asked—the first concerning the theoretical and practical advances of the past year, the second as to the line of progress in the immediate future. A large number of answers were received from electricians of various nations, and their responses are worth more than a passing notice. Nothing could show more clearly the keen appreciation of important theoretical advances than the almost unanimous answer that the most important recent work is to be found in the magnificent studies of Hertz on electromagnetic waves. As to electrical inventions, there was little unity of opinion. A few replies mentioned individual improvements like the modified phonograph, Desroziers' dynamo, and others, but, for the most part, little in the way of invention was mentioned. In the answers to the second question the spirit of the time is evident enough, for almost to a man the writers mentioned electrical traction and the long distance transmission of energy. A few answers suggested the improvement of the accumulator, the production of electricity direct from heat, and the magnificent possibility of light without heat, brought to our view by the splendid generalization of Hertz. This then is the sum of it all—for the near past, electromagnetic radiation, for the near future the development of electric power.

Changes in the Edison Company. ALTHOUGH the several Edison interests were consolidated some time ago into the Edison General Electric Company, the business of each of the different enterprises thus absorbed has since gone on very much as it did prior to the consolidation. There will probably soon be some changes in this respect. It is understood that the Edison General Company intends now to bring all the business under one general management, the lamp factory, the Sprague Company, the machine works, etc., being run hereafter as departments. Mr. Samuel Insull is to have general supervision over all these departments, the position of second vice-president having been created for him. What changes Mr. Insull may introduce remain to be seen, but it is safe to predict that the wisdom of concentrating the business in this way will soon be apparent, particularly as for the important and responsible position he is to occupy Mr. Insull is eminently "the right man in the right place." He is justly considered one of the brightest and one of the most capable men in the business. He is, moreover, exceedingly popular, and has a way of making a success of anything he undertakes. Although Mr. E. H. Johnson is devoting his own time to other matters, he is still a member of the board of directors of the Edison Company, and, as such, has, it is said, been one of the warmest advocates of the changes mentioned in this paragraph, and especially of the selection of Mr. Insull for the new position.

Increasing Traction by Electricity. THE subject of a possible adhesive action produced between wheel and rail on single trolley roads has frequently been alluded to, but in a very unsatisfactory manner. Statements have been plenty but facts few. In a communication published this week Mr. E. E. Ries discusses the general topic from the standpoint of a rather wide experience, and puts the *rationale* of the action very distinctly. He shows from the results of definite experiments that the electric current produces increased adhesion under certain circumstances. The condition for such action is that the current density over the areas of contact shall be great enough to produce strong surface heating even to the point of incipient welding. This naturally occurs with regularity only when the current is a powerful one, stronger than is met with, as a rule, in street railway practice. The welding or rather sticking action is instantaneous, and the subsequent cooling is so rapid that the opposed surfaces are not perceptibly affected. Naturally, the strongest effects are obtained when a powerful current, which need be but of very low voltage, is deliberately passed from wheel to rail. In this case a striking increase in adhesion is manifested. There may be an effect produced by the surface heating analogous to that in the "rocker," well known to students of acoustics, even with a comparatively small amount of current. In the case of street railways it is probable that the currents used are too small perceptibly to increase traction, except, possibly, on a dirty track where there is flashing under the wheels. On the whole, we are justified in assuming that there is no such action regularly present to a sensible extent, though it may be present often enough to give color to the popular opinion. As to the value of a current deliberately applied for the purpose of increasing adhesion, something may be judged from the tests reported by Mr. Ries, but the subject is now under experiment on a considerable scale, and future reports will give more extensive data.

How Long Shall We Suffer? To one who has the misfortune of being compelled to travel daily from lower Broadway to the upper end of New York, the rapid-transit problem has more than a casual interest—it becomes of vital importance. The elevated roads are glutted with passengers, until the traveller has a suffocating sympathy with old Giles Corey, pressed to death in the days of Salem witchcraft; while the surface roads cannot carry the throngs that swarm upon them. With every month the situation grows more serious, and legislative procrastination puts off the day of relief. We look with apprehension on the delay that would follow should the cable bill now before Governor Hill for consideration become a law. If transforming Manhattan Island into a gridiron of cable conduits could solve the prodigious problem, we should hail such a measure with joy; but unfortunately its only effect would be to put off real rapid transit until the cable had taught its lesson of failure, and to add another corporate interest to those that already clutch the streets. Fancy the result of a broken cable on Broadway in the late afternoon, paralyzing traffic for hours; and it should be remembered that the life of a cable is usually only a few months, sometimes only a few weeks. Aside from inconvenience, there is positive danger; for, with a cable running at a fixed rate, it is no easy matter to handle a car in a crowded street while, were a broken strand of cable to catch in the grip, as sometimes happens—happily not often—the car would run amuck through the press until some sickening disaster brought it to a stand-still. There are safety devices, it may be said, but one failure, such as has happened and may happen again, would teach a deadly lesson that would not soon be forgotten. If we must have rapid transit for surface roads, electricity is the only proper method, for an electric car can at least be operated at variable speeds in working through a jam, and brought to a sudden stop by reversing if needful. A man has even been knocked down by the dashboard of an electric car and the motors reversed in time to save him from being crushed under the wheels. But even electric surface roads could only alleviate the trouble; to remove it we must look to an underground system and again to electricity to relieve this of the noisome smoke and foul gases that pollute the air in the London tunnels. The cable bill only blocks the wheels of progress—connected, of course, with their appropriate armatures.

NEW BOOKS.

Directory of American Gas Companies. Compiled and corrected by E. C. Brown. 8vo, 184 and xlviii. pages. $5.

This is the third annual edition of a valuable handbook, to which we can best do justice by stating that its tables, figures and facts have been found in the past, and will be in the future, of great value to electricians as well as to gas-light operators. The book seems to be prepared conscientiously and carefully, and to contain, considering its nature, few errors and omissions.

The bulk of the volume is given up to a list of the gas companies of America, arranged alphabetically by States and towns. The companies thus treated are no less than 1,048 in number. Following the main portion of the work are lists of natural gas companies, of parent or operating companies, and of gas companies operating electric lights. These last, we observe, number 304, of which 155, or about one half, have adopted the Thomson-Houston system, and the others have divided their patronage very equitably between the other companies—the Westinghouse leading as to incandescents, the Brush as to arcs.

The Setting Up of Clark Standard Cells.

BY REGINALD A. FESSENDEN.

On account of its portability, constancy, and the accuracy with which its E. M. F. and temperature coefficient are known, there is no doubt that the Clark cell would be more generally used were it not that the present method of setting it up necessitates apparatus not commonly found outside of large establishments. The distillation of the mercury in vacuo, and the redistillation of the zinc, are particularly referred to. The preparation of the mercurous sulphate so that it contains no traces of "ic" salt also presents some difficulty.

The following method, it is hoped, will be found to be an improvement, as regards simplicity in manufacture by those not accustomed to such work. The chemicals necessary are commercial mercury, chemically pure zinc sulphate and chemically pure nitric and sulphuric acids.

Preparation of the mercurous sulphate.—The presence of small quantities of foreign materials in the mercury, as lead, antimony, etc., is of no consequence. But if a large quantity of zinc or other impurities is suspected, it should be distilled. This may be done as follows:

The test tube *A* (Fig. 1), two centimetres in diameter and ten or fifteen centimetres in length, is filled to the depth of one centimetre with mercury (which should not be allowed to touch the sides as it is put in). This is covered with a layer of iron filings to prevent spurting. The test tube is then heated in the middle, drawn out somewhat, and bent over, as shown at *H*. It is then heated in a sand bath to the lowest temperature at which the mercury distills. This distillate is received in a vessel *D*, containing a 5 per cent. solution of pure nitric acid.

As a rule, however, this distillation will not be necessary. The mercury is simply shaken up for ten or fifteen minutes with a 5 per cent. solution of pure nitric acid, then it is washed with water, dried, placed in a flat dish to expose as much surface as possible, and covered with an equal weight of nitric acid of specific gravity 1.2. The temperature of the acid and mercury should not exceed 15 degrees C. The dish is set aside in a cool place for from twelve to twenty-four hours, when large crystals of mercurous nitrate will have formed. Nearly all the impurities originally present in the mercury will now be contained in the mother-liquor. The crystals are removed (all yellow ones being replaced to be further acted upon), drained and washed quickly with a small amount of cold water. They are then dissolved in a 5 or 6 per cent. solution of nitric acid, which should not be warmer than 20 degrees C., when the decanted solution will consist of pure mercurous nitrate. This is precipitated by a 5 per cent. solution of pure sulphuric acid, added when cool and with constant stirring. The precipitate is washed by decantation with cold water until all acid taste is removed from the wash water. It is then washed a little more and drained, when it is ready to mix with the zinc sulphate. If the washing is carried on too far after free acid is no longer perceptible in the wash water, a basic mercurous sulphate is formed. This is of a yellow color, like turpeth mineral, but it has a different formula, as shown by analysis. It can always be formed, even in the absence of the slightest trace of "ic" salt, provided the mercurous sulphate is in a state of fine division, and the washing is carried on long enough. (A cell was made up from mercurous sulphate which had turned yellow, been thoroughly washed with water, and stirred up with 5 per cent. solution of sulphuric acid till it regained its white appearance, then washed as usual. It behaved normally, the acid salt seeming to have been taken out by the washing, and the basic salt to have been turned into normal mercurous sulphate by the acid.)

A basic green salt is formed when the waste water is too warm. The gray appearance sometimes taken on by the yellow salt when washed for a long time with cold water is an optical phenomenon depending on admixture of various basic salts. It is purposed, as soon as opportunity offers, ascertain the exact conditions under which these various salts are formed and their effect on the E. M. F. of the cell. The mercurous sulphate may also be prepared very easily by electrolysis, but as this method has the disadvantage of requiring pure mercury it is not given.

Preparation of the zinc sulphate solution.—To water that has been boiled and allowed to cool to 95 degrees C. is added about an equal weight of the non-hydrated zinc sulphate, or six to seven times its weight of the hydrated salt. After ten or fifteen minutes the solution is filtered quickly before its temperature has materially fallen. The first part that comes through the filter is mixed with the mercurous sulphate till it forms a moderately thick paste, when it is poured into the test tube *B* of the cell. As the cell is commonly

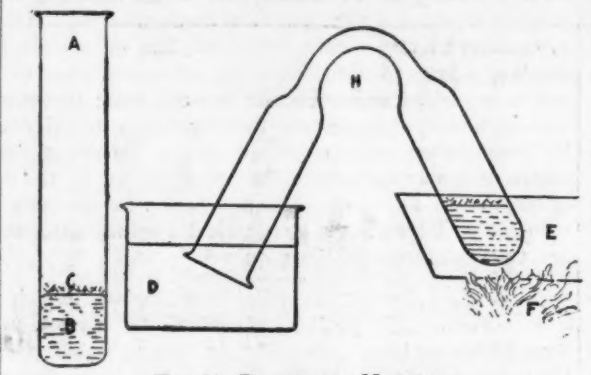


Fig 1.—Purifying Mercury.

made up, zinc carbonate is added to the paste till it ceases to effervesce, but if made up as here directed the paste will be already neutral.

The remainder of the zinc sulphate after filtration is allowed to cool to 20 degrees C., a crystal or so of zinc sulphate being placed at the bottom to promote crystallization. When this has occurred a part of the fluid portion is used to fill the cell and a few crystals are placed in both outer and inner test tubes.

Preparation of the electrodes.—One end of a piece of platinum wire, ¼ millimeter or less in diameter and about 3 centimetres in length, is raised to a white heat. At the same time a piece of thin copper wire is heated till it begins to fuse at the end, when it is touched with the end of the platinum wire and the two are withdrawn from the flame. By this means a good joint is made between them.

Fig. 2.—Electrode.

The wires so joined are placed in a glass tube about 8 millimetres diameter and 3 centimetres length so that the joint is 5 millimeters from one end of the tube and within it (Fig. 2). The end *A* of the tube is then heated till it softens and closes about the platinum wire. The process is repeated in forming the other electrode.

A portion of the washed mercury is placed in a test tube, as shown in Fig. 3, and on top of it is poured a 5 or 10 per cent. solution of sulphuric acid. The electrodes are cleaned by alternately raising them to a white heat and dipping them in hydrochloric acid several times. One of them is coiled into a spiral so as to fit inside the smaller test tube of the cell and is placed with the spiral dipping into the sulphuric acid, as at *H*, Fig. 3. The other electrode dips beneath the mercury *M*. A current of electricity is then passed between the electrodes in such a direction that mercury will be deposited at *H*. A platinum amalgam is

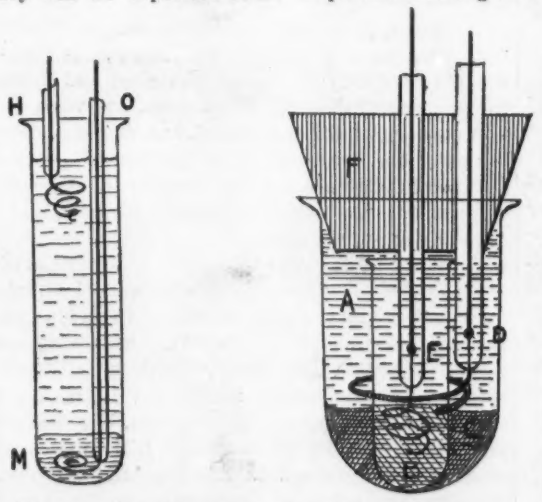


Fig. 3.—Arrangement of a Clark Cell.

thus formed free from all impurity, as lead, antimony, etc., are not deposited under these circumstances.

In forming the zinc electrode, the platinum wire is flattened into a thin ribbon bent into such a shape that it will encircle the smaller test tube of the cell, and zinc deposited on it to the thickness of two or three millimeters from a solution of pure zinc sulphate, using a commercial zinc cathode. It should not be exposed too much to the air, but placed immediately in the cell.

The cell itself (Fig. 3) is made as follows: The test tube *B* is placed inside the larger test tube *A*, and paraffin poured in till it fills the space *C*. The rubber cork *F* (after the holes, which are to receive the electrodes, have been pierced in it) is boiled in strong caustic potash for half an hour, and then scrubbed thoroughly inside the holes as well, and rinsed in pure water. The size of the test tubes and cork is so arranged that with a little extra pressure the latter may be inserted so far as completely to close *B*, thus preventing any short-circuiting of the cell during carriage.

The zinc electrode should be kept well down to the bottom of *A*, as after a cool night it takes some time for the zinc sulphate in the upper part of the cell to become saturated again. The cell should be kept from light.

The Metropolitan Museum by Electric Light.

New Yorkers are probably all familiar with the long struggle that has taken place over the question of opening the Metropolitan Museum to the public after dark. This struggle has interested electricians not merely on its own account, but also because it has been hoped that a victory here would mean a similar advance in several other quasi-public buildings in New York. Among the most important of these are the Museum of Natural History (where the forces of darkness capitulated even sooner than at the Metropolitan) and the Astor Library. The latter institution, unfortunately, continues its policy of short hours, and for this reason is perhaps of less service to students and others than the great hall of the Columbia College Library, where some six years ago the Edison light was introduced, and where readers and investigators are received every day in the year, Sundays excepted, until 10 P. M. The Metropolitan Museum plant, of which we are glad to present a number of illustrations this week, is in some respects the most important of its kind in America. It is important for its great capacity, 2,800 lamps being used whenever the museum is open at night, and also for its demonstration of the fact that by electric light the art treasures of the world can be seen to almost as great advantage as they can by the light of day.

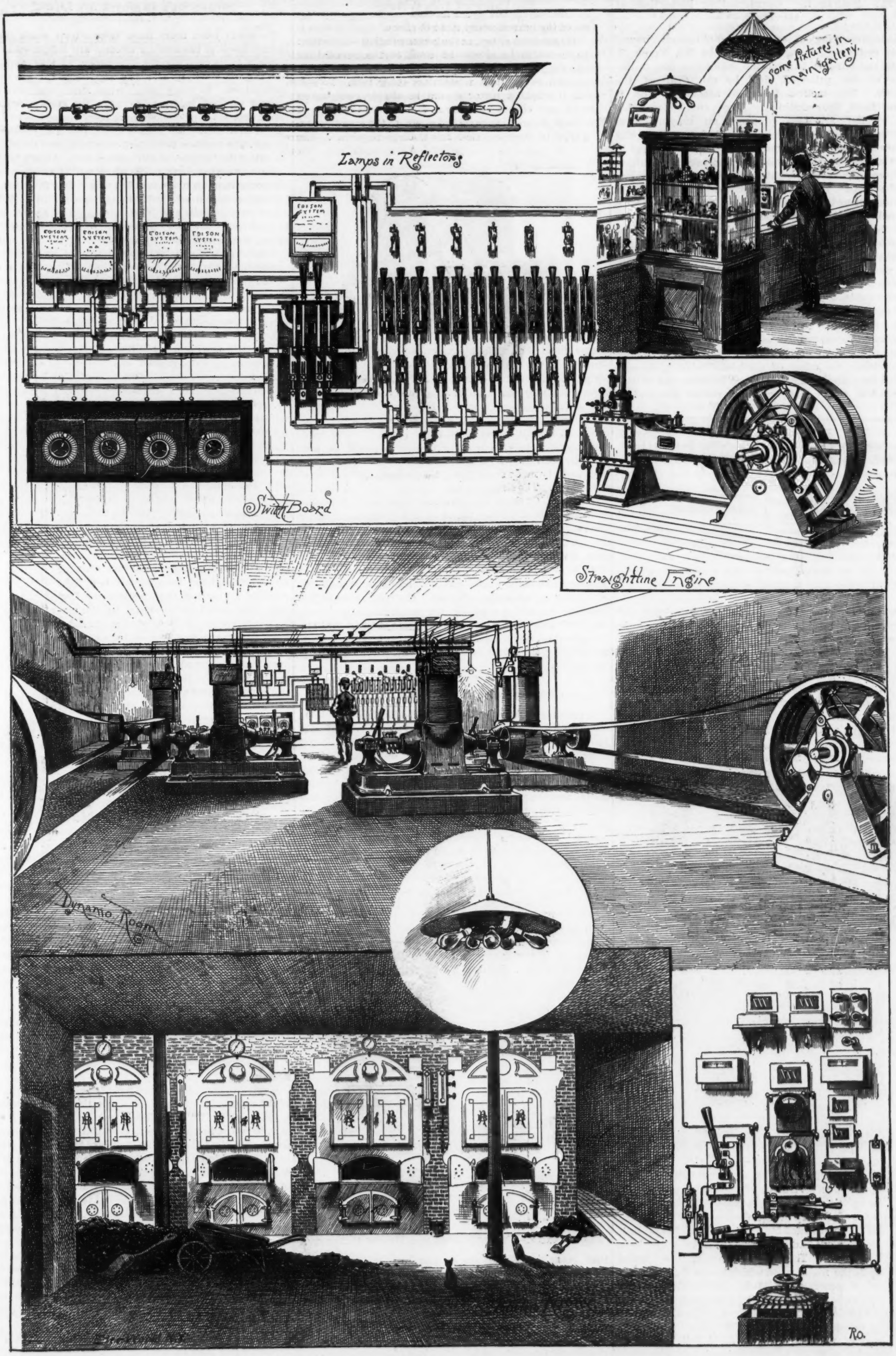
If it be granted that museums and libraries are to be open to the public at a time when the public can visit them,—and by this we mean to imply that upon ordinary week days the great public in America cannot visit these institutions—then it must be conceded without a shadow of doubt that the electric light is the only one fit to be used. No one who has not attempted the care of books and pictures subjected to the danger of illumination by gas, with its accompanying destruction of the atmosphere, can form any idea of the ruin that that form of light would produce in these institutions.

The plant at the Metropolitan Museum of Art consists of four Edison No. 16 compound dynamos, driven by two 125 h. p. Straight Line double valve engines furnished by Williams & Potter, the agents in New York city of the Straight Line Engine Company, of Syracuse, N. Y. The boiler room shown in our illustration contains four Rutzler & Blake boilers, two of which are 16 × 4½ and the other two 14 × 4½ feet, with a pressure of 90 pounds. It is to be noted that in one feature the work expected from this plant is unusual, since, when the plant is running at all, it is required to furnish practically its entire complement of lights. It has been found necessary, however, to use artificial light in the class rooms of the art school connected with the museum, and for this purpose there have been installed 60 cells of the Electrical Accumulator Company's storage batteries connected in series. These cells are charged not more than twice a week, and have thus far done their work with entire satisfaction.

One of our illustrations shows a novel design of switch used for running the two and three-wire systems either together or separately. This switch is intended to perform the same work as that in the Edison laboratory, illustrated by us on April 5, 1890, but is simpler in design and quite as effective in operation. Its purpose is to change the connection of a pair of dynamos running on the three-wire system so as to convert the distribution into a pair of two-wire systems. The main switchboard shown in our illustration is a model of its kind. The connections are all copper bars, and it has been designed with a view to artistic as well as practical perfection. The minor switchboard shown is for the accumulators and miscellaneous work.

The installation of this plant has been somewhat hampered by the fact that it was necessary to use the existing cellar in the museum, and for this reason the quarters are somewhat cramped. These difficulties have been overcome with very commendable success, but it is hoped that when the new wing of the museum is constructed, in the course of a year or two, ample space will be afforded for setting up an ideal plant.

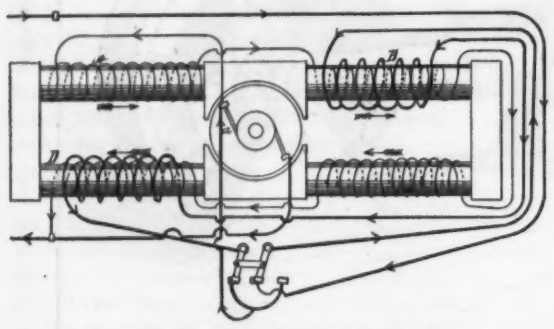
One of the main features of this plant is the manner in which the light has been distributed throughout the halls. To avoid objectionable shadows, to throw the light in just the right way, to leave no dark corners, and yet not to overdo the brilliancy at other points—all this involved very careful work; and that this work has been admirably done is attested by the fact that the lighting of the museum is so perfect that its difficulties are not thought of by those who visit the halls at night. The fixtures are absolutely simple, and in many cases quite out of sight, yet the light obtained from them does justice, we think, to each picture and to every statue in the building. Mr. Julius Calisch, the electrician in charge of the plant, naturally takes a commendable pride in the success that has attended its installation, and his efforts to make it as satisfactory as possible are being rewarded by the approval of the great crowds of visitors that are seen in the building every Tuesday and Saturday evening, as well as by the admiration of the work expressed by the many electricians who have inspected it.



LIGHTING THE METROPOLITAN MUSEUM OF ART BY ELECTRICITY.

Sprague's Method for Counteracting Distortion of the Field.

The accompanying cut represents a differentially wound electric motor or generator, devised by Mr. Frank J. Sprague and intended to avoid the difficulties due to distortion of the principal field by the field of the armature. The method taken to accomplish this is obvious from the windings. The cross-magnetizing effect of the armature produces an unsymmetrical field, and if the field produced by the regular magnetizing coils be a symmetrical one, this effect of the armature may produce sparking and other difficulties. Mr. Sprague, however, counteracts this effect by winding the field with unsymmetrical series coils so that the distortion produced by the armature is in whole or in part counteracted by that produced by the series winding. It is evident that if a dynamo-electric machine be compound wound by this method the magnetizing effect of the armature will be in great measure avoided, and the sparking which usually accompanies it much reduced. Just how perfectly Mr. Sprague's device will accomplish this end remains to be seen, but it is exceedingly ingenious and undoubtedly will tend to produce the effect desired. Whether the two cross-magnetizing forces can be balanced so as to produce a uniform field can be proved only by experiment. In ordinary machines the effect of compound winding is only adjusted for a single position at the brushes, and if this new winding of Mr. Sprague's can render the field so



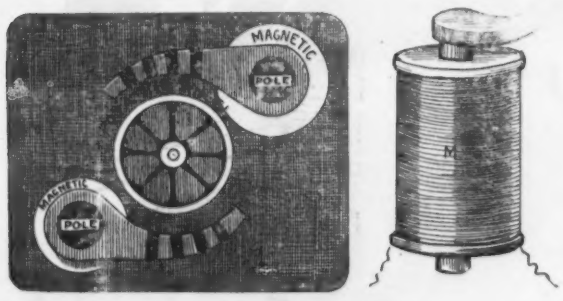
New Compound Winding.

uniform that the brushes do not require to be shifted with change of load, it will be a distinct advance toward the ideal method of compounding.

The Wright-Ferranti Alternating-Current Meter.

We cull from *The Electrician*, London, a brief illustrated description of an ingenious form of alternating-current meter which has recently been devised by Messrs. Arthur Wright and S. Z. de Ferranti, as described by Dr. Fleming.

In the accompanying figures we have a rough diagram-



Wright-Ferranti Meter.

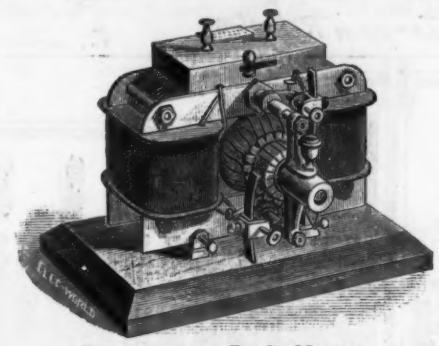
matic representation of this meter. It consists in its latest form of a pair of vertical electro-magnets, the magnets having divided iron cores. To the poles of these magnets are attached curved horns of divided iron which lie in a horizontal plane. These curved horns are magnetically throttled at intervals along their length with copper bands. The curved horns embrace a circular space in which can revolve a light copper or iron shallow cylinder of thin metal. This cylindrical band forms the periphery of a light wheel capable of rotation on a vertical axis. Geared to this axis is a counting mechanism. The axis also carries a vane having mica blades.

The electromagnetic principle, says Dr. Fleming, may be briefly described thus: The throttling of the curved iron horns causes the rapidly reversed magnetism to take the form of a lateral diffusion of lines of force from the sides of the horns. In effect a series of oppositely-named magnetic poles travels along the horn from the base, where it is in contact with the top of the electromagnet to the tip. These poles are represented by a series of bunches of lines of force, setting out laterally from the sides of the horn and traveling up it. The lateral passage of these lines of force through the metal band which forms the rim of the movable wheel generates in it eddy currents. These are continually repelled by the moving field producing them, and hence a motion of rotation is given to the wheel by the alternating magnetism of the magnetic poles.

The speed of rotation, being retarded suitably by the vanes, can be made to be proportional to the current strength of the current exciting the magnets, and hence the total turns of the wheel in a given time to the total electric quantity flowing through the meter.

The Improved A. B. C. Motor.

One of the neatest additions to the list of small motors is the little machine shown in the accompanying illustration. There seems to be almost no limit to the demand for motors for domestic purposes, running sewing machines, fans, small pumps, and numberless other uses. To succeed in this field, a motor should be simple, easily taken care of, and cheap; and the A. B. C. Motor Company of New York seems to have settled down to the manufacture of a type of machine that fulfils these requisites. The



Improved A. B. C. Motor.

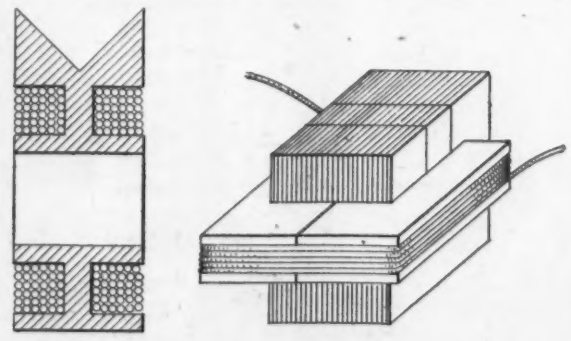
motor shown has a double magnetic circuit, thoroughly laminated, the joints being woven between alternate strips and the whole clamped firmly together, so that by reason of plenty of good iron the field is easily maintained. The armature is made either of the plain Siemens type or with deep grooves forming Pacinotti projections cut along it, with a slight spiral slope to avoid dead points and steady the magnetic action. As will be seen from the cut, the whole arrangement is compact, and the tests already made show a very good efficiency for so small a machine. The sizes now on the market are $\frac{1}{12}$, $\frac{1}{8}$, $\frac{1}{6}$, $\frac{1}{4}$, $\frac{1}{2}$ and $\frac{3}{4}$ h. p. Of these the three larger sizes are made for voltages up to 220, while the smaller machines are made for the ordinary 110 volt incandescent circuits. The $\frac{1}{12}$ h. p. motor is also wound especially for battery service to run fans, sewing machines and the like, and requires about 8 volts to develop its rated power, although for the above purposes two battery cells giving 7 ampères at half the above voltage are quite sufficient. The larger sizes of this machine are also wound for use as dynamos, and work very satisfactorily. This improved form of the A B C motor seems, on the whole, to be a meritorious newcomer, and will doubtless find its way into public notice and appreciation.

A Remarkable Instance of Short-Circuiting.

A peculiar accident happened to the East Liverpool, O., Western Electric Company a short time ago that will be of interest to the electrical fraternity. Their switch-board caught fire, machine began "flashing," and lights went out. Upon examination, it was found that an ordinary card photograph had by some means fallen into the switch-board, and the gilt edge around it had come in contact with the two ends of the line, causing a short circuit with the above result. The wires were separated from the switch-board, united temporarily with connectors, and everything was started up again, with a stoppage of only a few minutes.

Lemp's Transformer for Heavy Currents.

When transformers are designed to produce very large currents the question of winding the secondary becomes a difficult one. Mr. Lemp has devised the ingenious method illustrated herewith of avoiding this difficulty in a very complete manner. He does it by making the secondary a solid mass of copper, having a groove or depression in its side or edge in which lies the primary coil. By this arrangement the secondary can be made as a single casting and the primary wound over it, or, in some cases, wound on a bobbin and slipped over it. The secondary



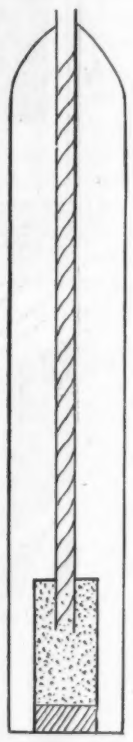
Figs. 1 and 2.—Transformers for Heavy Currents.

thus consists of a single turn of a great cross section and consequently enormous carrying power, while the construction of the transformer is rendered exceedingly simple. Figure 1 gives a cross section of the secondary bar, and figure 2 shows a perspective view of a modification of the same general idea. Transformers of this type have been made at the works of the Thomson Electric Welding Company and proved very convenient and efficient. Of course they are specially designed for welding purposes. The form is notable as singularly compact and easy to make.

Saunderson's Improved Arc Light.*

For many years there have been efforts made for the improvement of carbons for electric arc lamps with some measure of success, also for introducing various materials into the arc, but in no case has any important advantage been gained. In many cases certain substances have been ground up and incorporated with the carbon, with the result that ashes or clinkers have been formed to such an extent as to render the light of less, rather than greater, intensity. The most successful carbons have been those made up with finely powdered soft carbon dust. A very remarkable discovery has been made which will certainly give an enormous impetus to electric lighting. The inventor, Mr. Llewellyn Saunderson, of Kingstown, County Dublin, whilst experimenting with the arc lamp in his endeavors to improve its powers to pierce fog, so as to minimize loss at sea, determined upon introducing into the arc minute quantities of intensely heated hydrocarbon vapor so as to enrich the light with the well known fog-piercing rays —viz., yellow and red. Having succeeded by this means in producing a beautiful sunshine yellow, he discovered that at the same time the intensity of the light was enormously increased.

A plant was put down consisting of gas-engine, dynamo and electric arc lamps, and the question was followed up by introducing various gases into the arc in a number of curious ways, only a few of which can now be described. The first consisted of a jet through which the vapor was projected into the arc, then two jets, and so with a number of other contrivances. The hydrocarbon was vaporized in the tube leading to the jet, and retarded in its passage by asbestos, etc., to give the carbon time to bring the vapor up to an intense heat, and a wick was employed to prevent the vapor from going back, as well as to supply fresh fluid by capillary action. Having thoroughly convinced himself that a substantial improvement of the light could be produced without requiring additional power from his gas-engine and dynamo, the inventor now contemplated bringing his new light forward for actual tests against the best light that could be produced by the carbons now universally employed in arc lighting. He made inquiries as to whom he should ask to assist him, and Lord Crawford very kindly allowed some temporary tests to be made at the store of the London Electric Supply Corporation in the Adelphi-terrace, but the exigencies of the business of the corporation were such that the long and laborious investigations required could not be continued. Subsequently the inventor was recommended to apply to Mr. Apps, 433 Strand, London, so well known for his work in connection with physical science, and after careful consultation it was decided to put down a plant consisting of gas-engine, dynamo, storage cells and two large Brockie-Pell arc lamps, each taking about 45 volts and 12 ampères. This plant began running in May of last year, and was designed and fitted up by Mr. Apps with a full complement of testing instruments of the most approved design. The two lamps were arranged at the ends of a long photometer scale, the photometer being in the centre, and the lamps vertically placed at each end. The exact candle power of either lamp was not thought to be important, but the precise relation of the lights of the two lamps was the point to be ascertained, the energy supplied to each being indicated by the sets of instruments placed on the walls opposite. At this stage the experiments were greatly extended, and many thousand observations taken, with a general mean result agreeing with that separately and afterwards determined by Dr. Hopkinson. It was found, however, that for very exact measurements greater steadiness was absolutely necessary.



Carbon with Wick.

Having now procured readings of a reliable nature, and of the most extraordinary character, the inventor was advised to call in Dr. John Hopkinson, M.A., D.Sc., F.R.S., etc., to report to him on the power of the new light as compared with the old arc light. A pair of black velvet screens were ordered to be placed behind the lamps, and the whole of the framework also was colored a dull black. The tubes of the photometers were also lined with black velvet, and special arrangements were contrived to get the maximum steadiness of light from the lamps. At this point some measurements were taken which were fully verified subsequently, but the unsteadiness of the light was still a serious source of difficulty. The lamps were now made to rotate in their own frames, and to be inclinable at any angle, also the automatic regulating mechanism being entirely removed, and a screw arrangement added for hand regulation. By this means the possible errors due to craters were almost entirely eliminated, and, after taking a great number of readings, Dr. Hopkinson decided to make his report, which is as follows:

"The peculiar feature of this invention is that the lower or negative carbon is hollow, and is connected with a reser-

*The Electrical Engineer, London.

voir of hydrocarbon, as tried by me, Young's paraffin, density 0.865. This oil passes up the hollow carbon into the arc.

"The object of my experiments was to ascertain what advantage, if any, resulted from the presence of the hydrocarbon. Two arc lamps were provided, identical in all respects, with the exception that to one of them the invention was applied. The E. M. F. and current supplied to each arc were measured by voltmeters and ampère-meters, which were afterwards compared with each other, and were found to give the same indications for the same currents. The lights given by the two arcs were compared by a photometer, generally of the ordinary construction. In a part of the experiments the ordinary Bunsen grease spot was replaced by the so-called Joel's photometer, consisting of two pieces of obscured glass; the results with the two instruments are in fair accord.

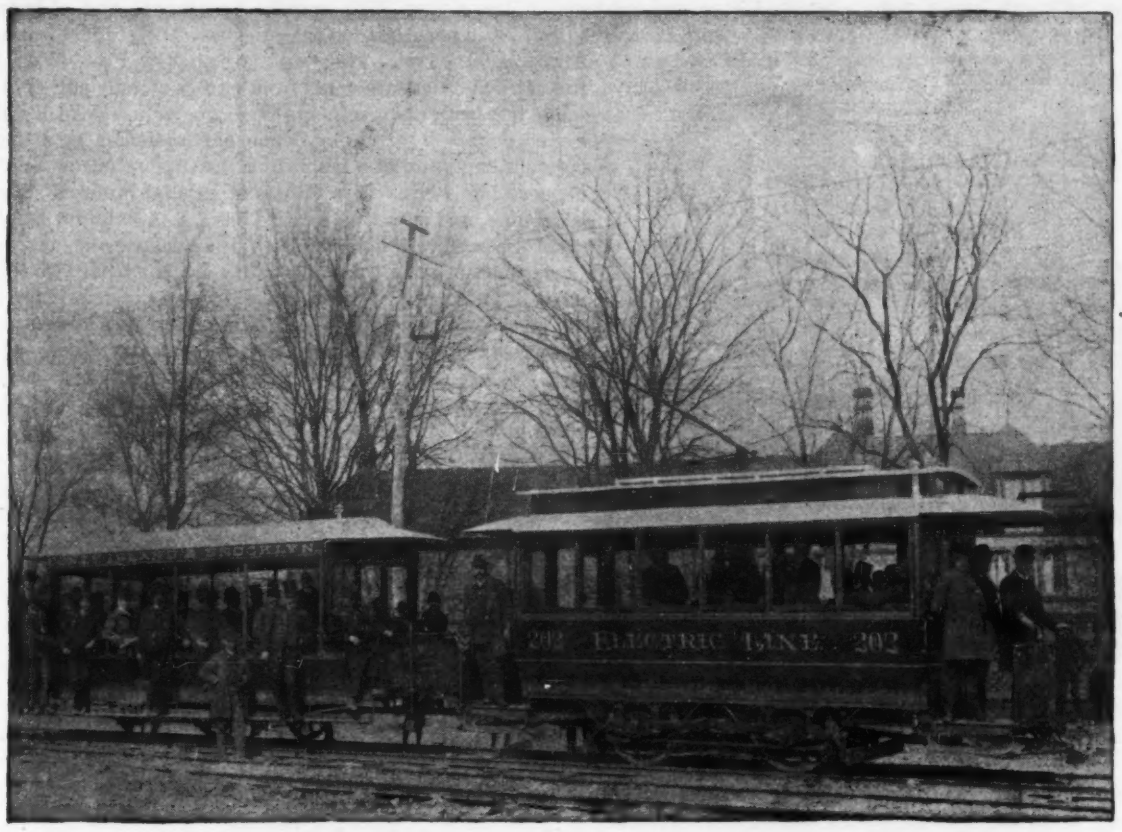
"In order to diminish the very considerable variation dependent upon the position of the crater, the lamps were inclined so that the axes of the carbons made an angle of 45 degrees with the horizontal, the craters in the two upper carbons facing each other. Between successive observations the lamps were turned through an angle of 180 degrees about the axes of the carbons, so as to reverse the favorable or unfavorable position of the craters. As might be expected, the observations varied very considerably, and the mean of the observations only is given here. In obtaining this mean, the whole of the observations are included with the exception of six—three extremely favorable to the new lamp; three, on the other hand, unfavorable.

"The final result which I find is this: Mean potential of ordinary lamp, 39.8 volts; of new lamp, 41.4 volts; mean current of ordinary lamp, 12.4 ampères; mean current of new lamps, 11.1 ampères; mean energy in ordinary lamp, 493.5 watts; mean energy of new lamp, 459.5 watts; mean ratio of the light given by the new lamp to the light given by the old lamp, 1.88. Thus, in these experiments, while consuming somewhat less energy, the new lamp gave nearly double as much light as the old lamp. There is, therefore, in an arc of this size a substantial advantage from the use of the invention. J. HOPKINSON."

Among the great advantages of this discovery we may mention increased steadiness; and, instead of the bluish tint always present in the ordinary arc, a fine rich, yellowish-white color, very agreeable to the human eye, is produced, being almost exactly the same as sunlight, and having, it is said, an enormously increased power of penetrating fog, so important for lighthouse purposes and for use in the military and naval electric light projectors.

The item of expense in applying the new system is so small that it may be neglected altogether, and very little or no alteration of the present arc lamps is required. The simplicity and cheapness of manufacture is, in fact, so great that it is probable not more than 20 per cent. or 30 per cent. in total cost need be added to the present cost of the carbons, against the diminution of the general cost.

It may be asked how these results are attained. Up to this moment there is, perhaps, no sufficient explanation, but it is highly probable that the exceedingly fine particles introduced into the arc, and impinging against the upper carbon by the ascent of the hydrocarbon vapor, are acted upon with great advantage by the electrical energy, whereas the harder particles of the carbons have to be taken from their state of cohesion, greatly reduced in size, and even then only a small percentage are found suitable for the higher incandescence (from which most of the light is derived), the grosser particles falling in dust, found after the lamp has gone out: while portions more refractory are discharged at all angles, and sometimes with considerable force. For instance, such particles have been found embedded in the surface of massive glass lenses placed some four or five inches distant from the arc flame in a horizontal direction. The work done in heating a refractory and unsuitable body for the production of light must evidently be attended by considerable loss of energy. On the other hand, the hydrocarbon vapor is (by means of the waste heat of the carbon, at a point not far from its lower end) obtained from the absorbent wick, from which it ascends, being lighter than the surrounding air, and after being raised to an intense heat as it passes upwards, and having enormously expanded, it passes into the arc. The quantity of vapor required is astonishingly small that which can be produced from a drop of oil lasting, with ordinary carbons, nearly a minute. It is, however, not necessary to employ oil, but almost any substance or semi-liquid which, on being heated, gives off the vapor, will answer well. For example, vaseline inclosed in a small capsule of the same size as the rod of carbon, and not more than about ½ inch long, will hold sufficient for the burning of the carbon down to the usual length at which it is generally taken out and thrown away. It is probable that the minute quantity of vapor required is acted upon freely, and that in its turn the incandescent gas or particles of vapor assist largely in effecting the separation of the particles of the carbon electrodes, for the consumption of carbon is increased by about one-seventh part. The light is said to be far more agreeable to the eye, and of much greater steadiness, while as to economy, arc lighting with this improvement, it is contended, is equal to gas at about 3d. per 1,000 cubic feet. With reference to search-lights, it is evident that by adopting the invention the illuminating power, and generally the actual value of these appliances, will be doubled, which may be an important factor in some not very distant naval action.



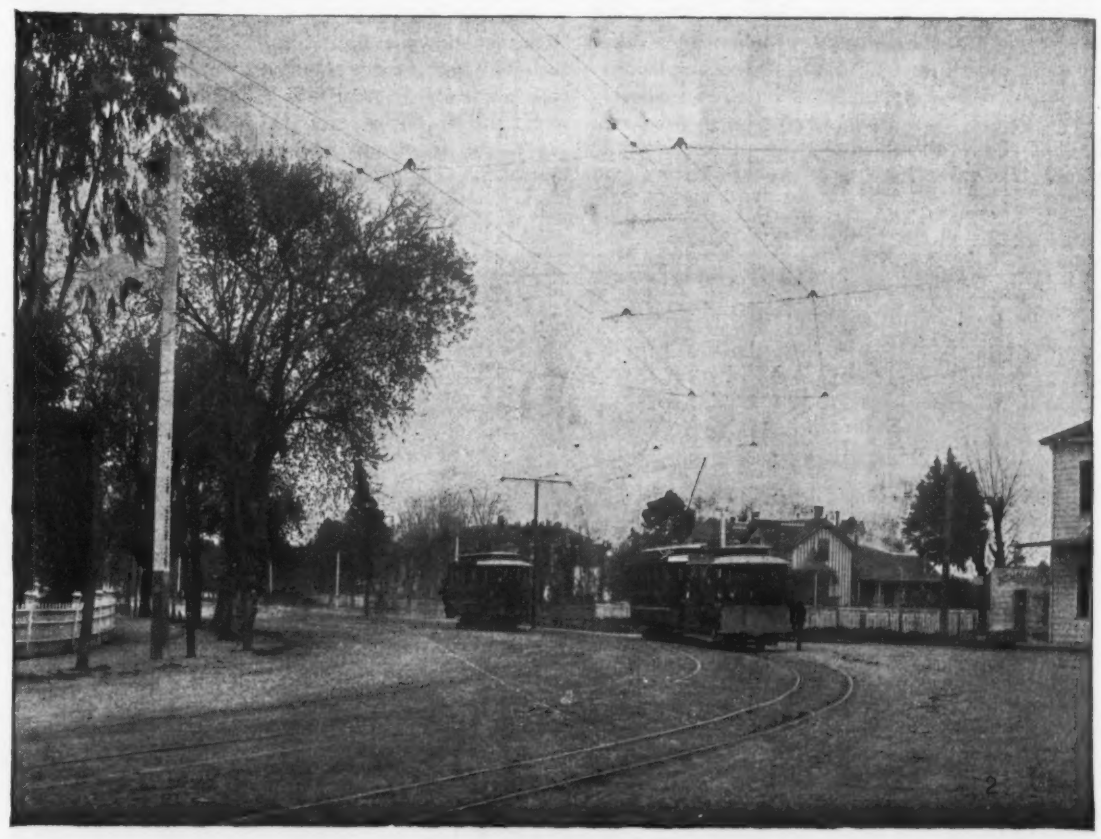
THE BROOKLYN & CONEY ISLAND RAILROAD.

Two New Electric Railways.

We give on this page illustrations taken on the line to two railways recently equipped by the Thomson-Houston Electric Company, one in the far West, and the other, let it be said with reverent praise, near enough to New York to permit the benighted residents of the metropolis to see for themselves the beauties of electrical traction. It is remarkable that up to the present the metropolitan district has been behind the rest of the country in this respect; and now that a start has been made, it is to be hoped that all our suburban roads, at least, will soon adopt electricity as their motive power.

The Brooklyn & Coney Island Railroad consists of sixteen miles of track, which is equipped with centre pole double bracket suspension, the trolley wire being suspended from poles placed between the tracks 125 feet apart, and provided with ornamental iron brackets. The construction is done in the most thorough and workmanlike manner, and the general artistic appearance of the line has caused much favorable comment. The car equipment consists of twelve double motor cars, and others will soon be added. The station is provided with the necessary boilers for supplying steam to three 200 h. p. engines, and the usual heaters, pumps, etc. The electrical apparatus consists of six 100 h. p. Thomson-Houston railway generators of the four-pole type and switchboard with the usual fittings. A part of the station is used as a car house and is provided with eight tracks with pits underneath, thus rendering the cleaning and repair work an easy matter.

The other view is on the San José and Santa Clara Railway, San José, Cal. This road is interesting, not only from its excellent construction, but in that it is the first railway in California equipped by the Thomson-Houston system. The road consists of nine miles of track, on which the double overhead construction has been used, and will operate six double motor cars.



SANTA CLARA RAILWAY, SAN JOSE, CAL.

Concerning Primary Batteries.

To the Editor of The Electrical World:

SIR: Will you kindly explain some method of obtaining the internal resistance of primary batteries? Why would not the application of Ohm's law answer for this? (2.) What is the theoretical amount of energy in a given amount of zinc?

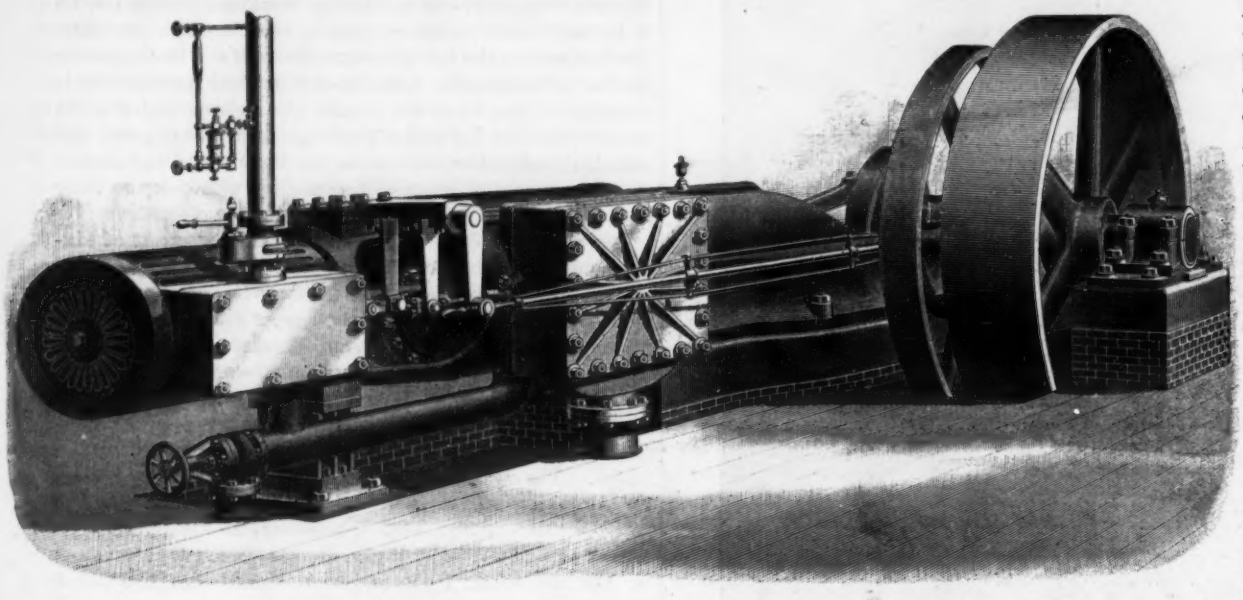
SUBSCRIBER.

[(1) The application of Ohm's law will give approximately the internal resistance of a battery, if you have a delicate voltmeter or other means of measuring the electro-motive force. For an exact determination other means are taken to eliminate polarization effects. (2) The theoretical amount of energy in a given amount of any material depends on the combination in which that material is to be used. In coal the theoretical energy generally referred to is the amount of energy to be obtained by combustion—that is, complete oxidation. The amount of energy to be obtained from a given amount of zinc would, then, depend on the way in which it is to be used.—ED. E. W.]

The Heavy Duty Rice Compound Engine.

It was some time ago announced that the John T. Noye Manufacturing Company, of Buffalo and 89 Liberty street, New York, manufacturers of the Rice automatic tandem compound condensing engine, intended to put on the market an engine of this type modified to meet the demands of higher duties, for electric tramway and power plants, rolling mills, and the like. This new engine we illustrate herewith.

The view presented is of the back, and is preferred because it shows clearly not only the valve motion and the governor, but also the cylinders and frame. The reader will note the low and unusually heavy frame; it is about 25 per cent. heavier than that of the standard engine, and the latter is among the heaviest on the market. This increase in mass, however, has not been allowed to detract from the looks of the engine, but is distributed with such nice judgment as to give it an appearance of graceful solidity that must please every eye, learned and unlearned. Fine lines, it is true, do not make a fine engine, but, given a good engine, they will add that which must surely strengthen an already favorable impression.



COMPOUND ENGINE FOR HEAVY ELECTRIC SERVICE.

With two exceptions—frame and governor—this heavy-duty Rice engine is practically identical in construction with the standard tandem compound engine. The crank disc being too small for the governing mechanism required on so large an engine, it has been found best to place the governor in the fly-wheel, or, in some cases, in a wheel of its own. The valve is then driven from a separate eccentric on the shaft; both valves being driven automatically by the governor. The valve itself is of the well-known grid-iron pattern, with four ports, and is so nicely balanced that it can easily be operated by hand, even when under full steam pressure.

The main bearing is provided with quarter boxes, in order that the wear may be taken up in any or all directions. These boxes are lined with genuine Babbitt metal, and then bored out to a perfect fit. The connecting rod is of forged steel, with a loop to contain the brasses for the crank-pin. This construction is more costly than that in the standard engine, but is warranted by the additional safety and strength which it gives. The crosshead has a suitable take-up for wear, and is so arranged that it cannot be tightened to the point of cutting.

Engineers will particularly appreciate the fact that in this engine the low-pressure piston head can be removed without disconnecting the high-pressure, and as well as the arrangement by which steam may be used in either cylinder without employing the other. We would also call their attention to the clearance, which is as small as considerations of safety will permit, and to the advantage which the sensitive governor gives, of considerable variation in speed.

Two engines have already been built from the new patterns: one for the South Bend Electric Light and Power Company, of South Bend, Ind., and the other for the Dakota elevator in this city. Neither of these engines has yet received the full load for which it is guaranteed; but their work so far has been of such a satisfactory character as to promise unusual efficiency.

New Series of Portable Testing and Resistance Sets.

The portable testing and resistance sets shown herewith were designed in the laboratory of Queen & Co., of Philadelphia, and are intended to meet the requirements of electric light men, telephone line construction, dynamo and motor manufacture, and general testing. They will be found well adapted to the location of faults in telegraph and electric light lines, determination of armature and field resistance of dynamos and motors, and the needs of government and other inspectors.

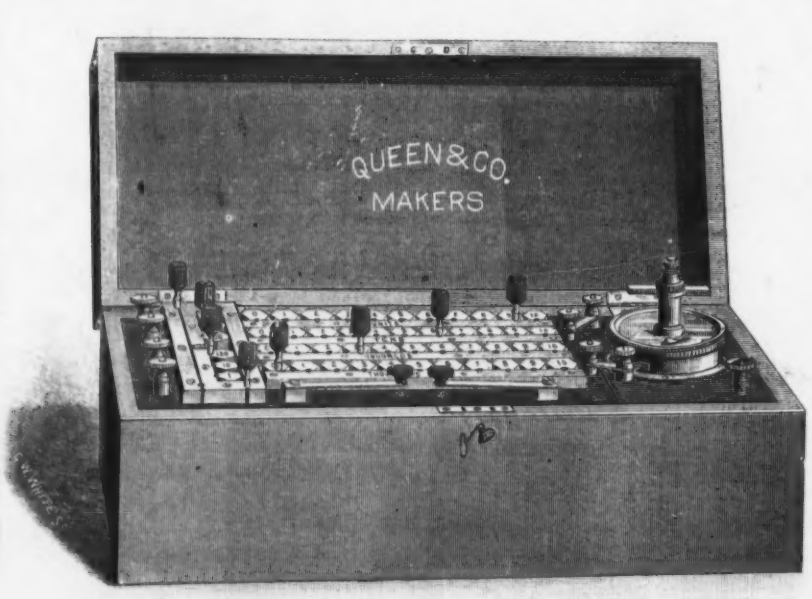
The set shown in fig. 1 is the best and most complete of the series and is recommended for work in which considerable accuracy is required. The coils in this set are, as is seen from the figure, arranged in four rows, each row being made up of ten coils of the same denomination; the blocks in each row are numbered from left to right and from zero to ten, while the longitudinal bars underneath have engraved upon them the denomination of the coils of that row. The connections of the coils are such that but one plug is required for each denomination; by inserting it in any block, as many coils of that denomination are thrown in as may be indicated by the particular number engraved upon the block; thus, as the cut represents it, there are in circuit 369 ohms, i. e., no thousands, three hundreds, six tens, and nine units. Another special feature of this set is the arrangement of the bridge arms, seen at the left; these are combined with reversing bars so that the proportionate arms may be instantly interchanged, an operation which is absolutely necessary in many special methods. An additional advantage is that but six coils are necessary in the bridge, instead of eight as usual, to get the proportion of 1 to 1,000 or 1,000 to 1, thus making the set smaller and more portable. The bridge coils are 1, 10 and 100 on one side, and 10, 100 and 1,000 on the other. To effect this reversal two plugs only have to be changed. This use of the reversing arrangement in testing sets is original with Messrs. Queen & Co., it having never before been employed except in the most expensive and elaborate laboratory instruments.

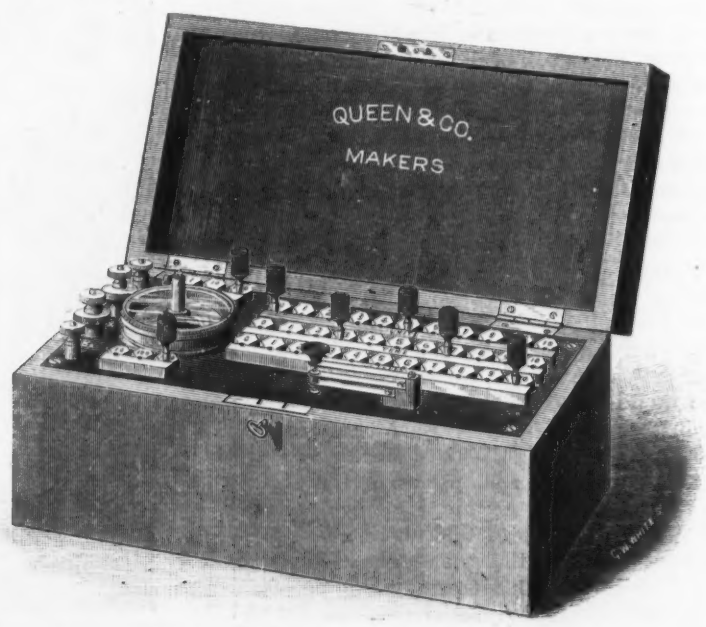
The coils are wound of the now famous platinoid wire, which has a very high specific resistance, and changes by but .0023 per cent. for each degree centigrade of temperature variation. They are adjusted by Prof. Wm. A Anthony to an accuracy of from $\frac{1}{2}$ to $\frac{1}{10}$ of one per cent., while the bridge arms themselves are adjusted to a still higher degree of accuracy. The galvanometer is a successful adaptation of a laboratory instrument to the needs of portable work. The wire is of several hundred ohms resistance, and is wound so as to have a maximum effect upon the needle; the needle itself is an astatic one, and delicately suspended by a very fine cocoon fibre, so that there is practically no resistance to any deflecting force. By means of a very weak controlling magnet sliding upon the suspension tube the needle can be made almost perfectly astatic, and will show an appreciable deflection for currents as small as from $\frac{1}{8000}$ to $\frac{1}{8000}$ of an ampère; the brass box containing needle and coil is movable about a vertical axis so that the needle can always be brought to zero whatever the position of the box as a whole. The whole galvanometer lifts out of its position in the case and can be used independently or in connection with other apparatus if desired, three levelling screws being provided for levelling when so used. By closing the cover of the box the weight of the needle is automatically taken from the fibre and the latter protected from injury. The battery and galvanometer key are seen in the front of the box, and are independent of each other. The whole is mounted in a polished mahogany box with leather handles, lock and key, and measures when complete but 18 inches long by 6½ inches broad.

The same set is made without the galvanometer; it is, of course, somewhat shorter. Both these sets have a range of measurement from $\frac{1}{1000}$ ohms to 10 megohms.

Fig. 2 shows one of the other sets of the series, and is of about the same general character. The coils, instead of platinoid, are made of German silver, and are not quite so accurately adjusted, while the set is without the reversing arrangement found in the ones first described. The galvanometer also is fibre-suspended, but without the automatic release; for this purpose a small set screw is used, which allows the needle to be lowered when not in use. The galvanometer is permanently mounted in the case, and is without the control magnet. The keys are combined into the regular double contact form. This set, as represented in the cut, has but three rows of resistance—viz.: the units, tens and hundreds; but it may be had with an additional row of thousands. It is made without the galvanometer.

A large number of the preceding sets have been sold in all parts of the country, and they have given great satisfaction. They have been worked upon for some time, and improved until their present satisfactory form has been reached. They are now being manufactured in large quantities by Messrs. Queen & Co., and introduced widely throughout the country.





FIGS. 1 AND 2.—PORTABLE TESTING AND RESISTANCE SETS.

Continuous-Current Transformers.

The first continuous-current transformer that has been installed for public supply has been erected in connection with the Chelsea Electric Station, London. The transformer is on Mr. Frank King's principle, and was immediately of use. The engines at the Court Theatre broke down, and the Chelsea Company was asked to supply current for the theatre from the mains, and, owing to the use of the continuous-current transformer, the current could be furnished at a moment's notice.

Electric Traction Data.*

BY A. RECKENZAUN.

Of the various questions connectioned with electric traction, the branch to which I have the honor of calling your attention to-night appears to me fundamental to a complete knowledge of the subject. It relates mainly to tractive force and mechanical resistances on tramways. It is a subject which is not as fully appreciated by electrical engineers as it should be, although it forms the very basis

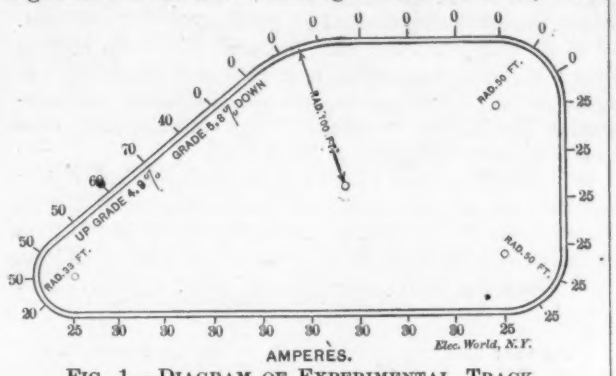


FIG. 1.—DIAGRAM OF EXPERIMENTAL TRACK.

of street locomotion, and I venture to say that future improvements in the economy of electric traction will in a large measure depend upon minute attention to details relating to this branch of the science. The very existence of tramways, as substitutes for the common road, is concentrated in one point, viz., the reduction of tractive resistance to a minimum.

It is a well-known fact that the traction expenses on horse tramways constitute about two-thirds of the entire working expenses, and it has long been the aim of engineers to find an economical mechanical substitute for animal power. Electricity has found great favor with tramway men in the United States, and there is every probability of similar developments in Europe at a not distant date. Improvements can only be brought about by experience, and experience must be gained in actual practice and by careful observation. These, again, can be supplemented by data obtained from those who preceded us, and it is my intention to bring, in a condensed form, such data, from which you will be able to draw your own conclusions, and which will guide you in future and progressive efforts.

In order to provide facility for traction, we must have a solid permanent way and excellent rolling surfaces. The practical value of a good rolling surface can scarcely be overestimated. The rails must be rigid, parallel, and fixed to solid foundations. In America flat step rails without grooves are used. These offer less resistance to traction than grooved rails, but, as a rule, they are not so solidly laid as English rails. According to Mr. D. K. Clark, the resistance to traction on an ordinary railway may be as low as six pounds per ton; but so low a resistance cannot be obtained with grooved rails which are exposed to the incidents of mud, grit, stones and dirt, and which, moreover, have frequent and sharp curves.

Mr. Henry Hughes deduced from experiments on tramways a tractive resistance of about 26 pounds per ton; often more, occasionally less. Such high resistances as these are readily accounted for, when it is considered that the flanges of the wheels frequently take a bearing on the bottom of the grooves, or on the dirt imbedded therein, at the same time that the wheels roll on the surface of the rail, for thus the wheel rolls on two different radii simultaneously, and grinding of surfaces in contact must result.

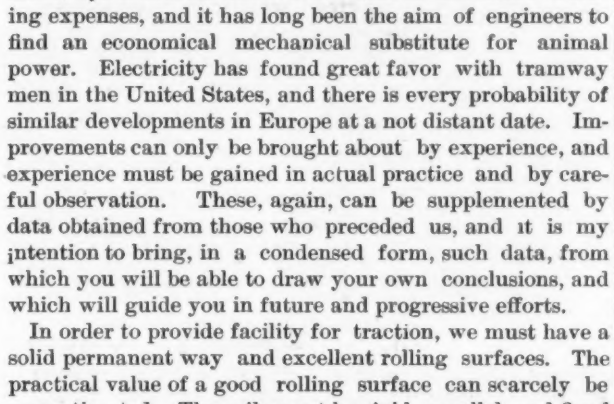


FIG. 2.—CURRENT VARIATION ON EXPERIMENTAL TRACK.

It may also occur that one wheel is running on its proper bearing surface, while the other, belonging to the same axle, has its flange touching the bottom of the groove, when, by virtue of different circumferential velocities, additional friction is introduced. Sometimes the rails are a little out of gauge. All these circumstances augment the tractive force requisite with grooved rails. The horse, if he could speak, would be a good witness, but, failing his verbal evidence, the dynamometer has been consulted. Better than the mechanical dynamometer, however, is, the ammeter. A dead beat ammeter indicates instantly the slightest variations of tractive resistances, and I venture to say that it will be through the judicious and more frequent applications of this instrument that material improvements both in the permanent way and in the rolling stock of electric tramways will be effected. •

* Paper read on Wednesday, April 30, before the Old Students' Association of the City and Guilds of London Institute.

Probably the most interesting and complete tests with horse cars were those made by M. Tresca. He proved, experimentally, that the groove in the rail was the direct cause of a large portion of the resistance to traction. An ordinary car with its four flanged wheels was propelled over the tracks of the Paris-Versailles tramway, and it was found that the average tractional resistance amounted to $\frac{1}{100}$th of the gross weight, or 22.4 lbs. per ton. Subsequently two of the flanged wheels, both on one side of the car, were removed and replaced by flangeless wheels, when the resistance, all other things remaining the same, amounted to only $\frac{1}{147}$th of the weight, or 15¼ lbs. per ton. The gross weight of car and passengers was 5.67 tons These experiments show conclusively that at least half the power is wasted in friction between the sides of the groove and the wheel flanges.

The force required to start a tram car and to get up

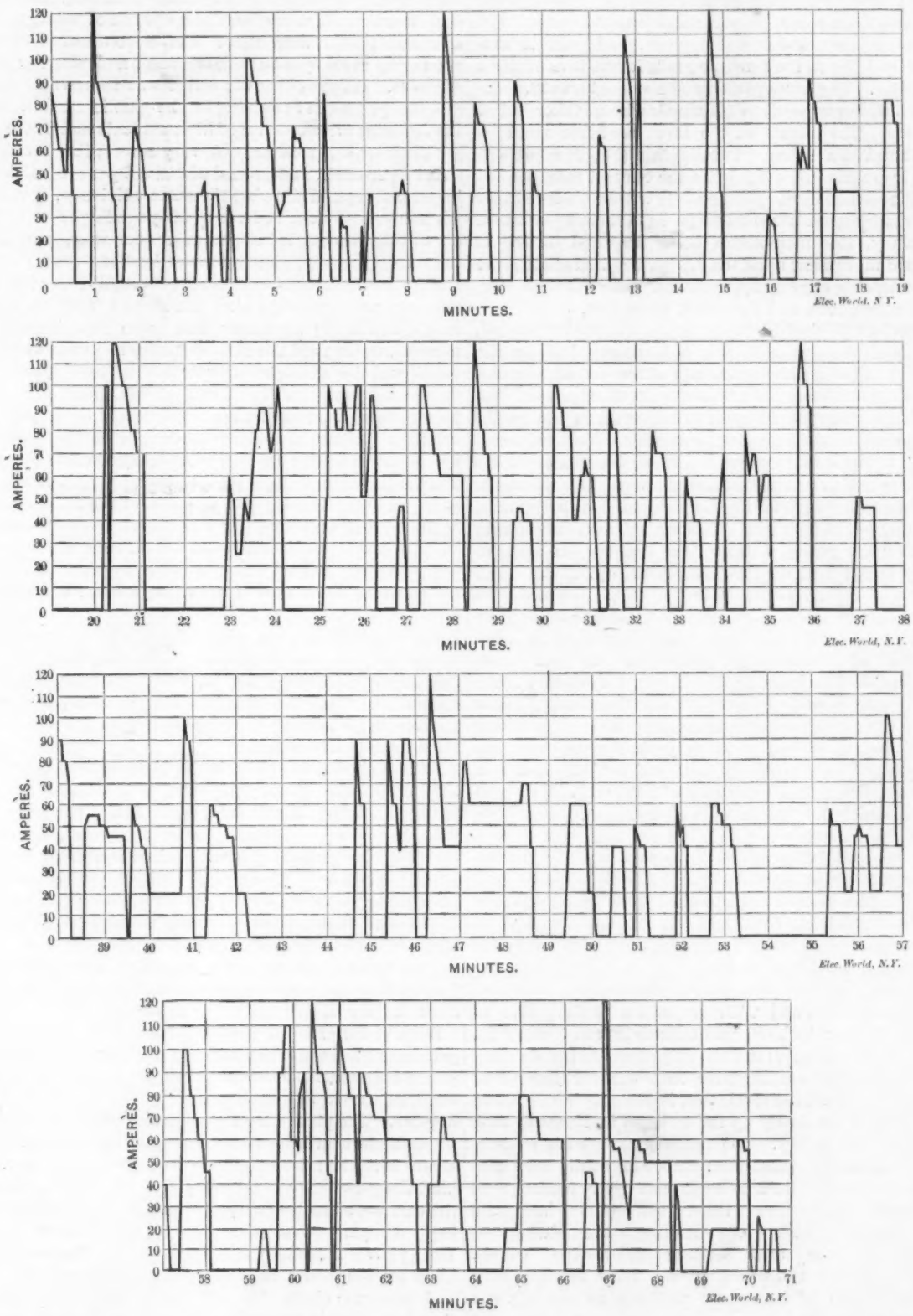


FIG. 3.—CURRENT VARIATIONS IN STREET SERVICE

speed is necessarily greater than the force required to maintain a given speed uniformly. It was found that the starting force is from four to five times that necessary for running on the level road. Curves also increase the resistance very much. In dry weather, on curves of 50 feet radius, the resistance to traction is doubled, and on those of 35 feet radius trebled; but when the rails are wet this resistance, due to curvature, is considerably reduced. Water, plenty of water, on the rails acts as an efficient lubricant, as you will see by statements later on the general effect of wet rails. Short wheel bases, bogies, or radiating axles render motion on curved rails easier, and flexible axle boxes are now greatly favored, especially in the United States, for the same reason.

The effect of gradients is a matter of simple calculation. It is the maximum gradient on a given line which determines the size and power of the electric motor. Allowing 22.4 pounds tractive force per ton, we should have to exert a pull of 134.4 pounds with a six-ton car on a level road. This, at the rate of seven miles an hour, or 616 feet per minute, would give us a 2.5 h. p. effective on the axles. If we have to overcome a gradient of 1 per cent., or 1 foot in 100, the resistance due to gravity will also be 22.4 pounds per ton; therefore we shall require about 5 h. p. to pull this car up a gradient of 1 in 100. With a 2 per cent. rise the power will be three times as great as on the level, and, roughly speaking, each per cent. of grade demands as much energy as the propulsion of a given weight on a horizontal road if the speed is to be constant. On steep gradients, however, it is customary to run slower, whereby some of the energy is saved at the expense of time.

The time at our disposal will not permit of descriptions of particular systems of electric traction, nor of the relative merits of each, and we shall confine ourselves entirely to statistics on tractive force, no matter how this force is transmitted; and we shall merely consider the question of moving a given load on a given track by means of the electric current. In order to ascertain the amount of energy used on electric cars, I have made, in conjunction with the Electric Car Company of America, a long series of systematic tests both on an experimental track built for this purpose, as also on the public roads under all sorts of conditions of traffic. Whilst on the experimental track we could run at any speed we liked, and without stoppages; on the public streets we were confined to the speed of horse cars in front and behind us, besides taking up and putting down passengers and regulating our vehicle to the general traffic of some of the busiest streets of Philadelphia.

This experimental track was laid in an irregularly shaped yard, as shown on the diagram No. 1, and it was intended to represent as difficult a line as is likely to occur in actual practice. Its entire length was 1,005 feet, the ends being so joined that the cars could circulate continually. Five and a quarter journeys round this track represented a mile run. There were four curves, two of 50 feet radius, one of 33 feet and one of 100 feet. Tangent with the 33-foot curve was a gradient of 4.89 per cent. rise, which descended on the other side at the rate of 5.8 per cent., and joined the curve with a radius of 100 feet.

On this track we carried out tests and recorded observations which may be counted by the hundred thousands. The following figures relate to experiments made with a car in the autumn and winter of 1887-88. The vehicle was an ordinary 16-foot two-horse car, with two axles, one motor and a set of storage batteries. It weighed, with several men on board, 5.3 tons; its wheel base was 6 feet, and one axle only was driven by an electric motor with intermediate spur gearing.

The rails were the ordinary American flat rails, grooved only at and near the curves, which represented a large percentage of the entire track. With a set of 84 cells of a nominal capacity of 150 ampère hours, this car made 230 trips around this track, representing an aggregate of 43.8 miles with one charge of batteries. The car was only stopped and started fourteen times. The actual running time was 6¼ hours, giving an average speed of seven miles an hour. At the commencement the E. M. F. of the cells on closed circuit was 160 volts, and at the end 145.2 volts; the average from actual measurement was 157 volts. The maximum current used on the steepest grade was 70 ampères at starting; on the curve or grade it rose to as much as 120 ampères. The average current consumed was 22.6 ampères, which corresponds to 141 ampère hours taken out of the battery. The current on the level road fluctuated between 18 and 25 ampères. The diagram (Fig. 1) representing this track has marked upon it the current rates used at the various points of the journey. It will be observed that the car ran by momentum during a considerable portion of the journey, this momentum being acquired during its downward movement upon the 5.8 per cent. gradient, the brake being only slightly applied, and the stoppages during this experiment, as I have said, being few.

A mean of 4.75 electrical horse power was thus expended, giving a consumption of 29.69 h. p. hours supplied by the battery; and the maximum energy given off at any moment was 10,500 watts, or 14 electrical horse power. Allowing an average efficiency of 75 per cent. in the motor and 85 per cent. in the gearing, we obtain a total efficiency of nearly 64 per cent. between the motor terminals and the axle, or about 3 h. p. available for traction. Thus the mean tractive force throughout the 43.8 miles run was 160 pounds, or about 30 pounds per ton. This is very low, considering that out of the entire distance we had only 21 miles of tolerably level track, the rest being made up of 3.4 miles of 33-feet curves, 7.07 of 50-feet curves, 3.64 miles of 100 feet curves, and 4.05 miles of ascending grades of 4.98 per cent. On the other hand, there were 3.8 miles of descending grades of 5.8 per cent. which furnished momentum right along the 100-foot curve until the car passed completely into the upper 50-foot curve on the right-hand side of the diagram. Converting the work into ton-miles, which is probably the most rational way of comparing figures, we get $5.3 \times 43.8 = 232.14$ ton-miles at an expenditure of 29.69 h. p. hours, and this gives nearly 7.78 ton miles per horse power hour. We have obtained much better results than this with a subsequent car containing various improvements, and, on one occasion, this larger car made 63 miles on the experimental track, each horse power hour producing 10.9 ton-miles; but these are exceptional feats, and our present object is to consider practical results corresponding with everyday work—industrial results, in fact.

Three men, each well trained for his work, were necessary for these tests, and their respective duties were as follows: One man took charge of the switch in front of the car and the hand-brake; in fact, he performed the ordinary function of a driver, taking care that the car moved at regulation speed on the level, that it did not "race" down grades, nor go too slowly up the inclines, and that it took the curves with safety. The second man, with a timepiece in his hand, counted the number of round trips and recorded the same; he also took voltmeter readings at equal intervals. The third attendant had the more difficult task of reading the deflections on the ammeter and writing down the values. In order to ensure uniformity in the time between each reading, and also take as many readings as possible, one has to learn to write down a certain number of figures in a given time, putting down ciphers to fill up time when the ammeter needle is at zero. The number of observations written down during the 43-mile test were close upon 7,500, or one reading every three seconds. Considering the rapid variations in the current on uneven tracks, it is very important that readings should be recorded at the shortest possible intervals, in order to arrive at a correct average. The specific gravity of the cells was tested before starting, when they were fully charged, and it averaged 1,126 degrees. At the end of 6¼ hours, when the cell was practically discharged, the density fell to about 1,186 degrees. The accumulators were then recharged for six hours at the rate of 30 ampères, when the electrotype assumed its original specific gravity. It is impossible to keep the acid in every cell at the same density; there are always slight differences, and we had to take the mean of the entire number of cells to insure accuracy. Figure 2 represents the currents used during six journeys round the experimental track, and this was virtually repeated throughout the tests, except when stopping and starting. Now compare this with figure 3, showing the current variations out in the crowded streets. You will observe a number of tall, narrow peaks running down to the zero line at frequent intervals. During these intervals the car was either stopping or running by momentum. The vertical lines in this diagram represent minutes and seconds, and the horizontal lines ampères measured on the car during the entire journey from Twenty-third street to the Exchange in Philadelphia and back to the Gray's Ferry depot, and from thence again to its starting point, a distance of about seven miles. Every corner on this diagram represents a movement of the switch by the driver.

The switch was constructed to throw the various distinct coils on the field magnets of the motor into parallel or in series, or into several intermediate steps, and these steps can be readily detected on the sharply defined junctions of the lines showing ampères. The average current consumed throughout this round trip, down town and back to the depot, amounted to 31 ampères. The weather was dry and windy, the road very dusty. Allowing for this, as well as the frequent stoppages and slowing down in order to keep pace with the horse cars on the same line, it appeared that there must have been some waste of energy. The diagram shows that there was a continuous effort of getting up great speed at one moment and slowing down the next. It shows that the driver was somewhat nervous and inexperienced in driving in the public streets, hence the frequent alternate use of high currents and brake. The gradients on this road are not very severe; the heaviest is about 4 per cent., and several of 2 and 3 per cent. Calculating as before, and allowing the same efficiency, we should get an average tractive force of 39 pounds per ton. The car in this case carried 23 passengers one way, and 30 on the return journey, giving a mean load of 7 tons.

Numerous journeys were made through the city with this car, and some days after the above event I took again careful readings; the driver was more experienced, less nervous, never used the utmost electrical power at his disposal, and the average current during two round trips came to only 23.11 ampères—25 per cent. less than formerly, under similar conditions of load, speed and weather. Although the average height of the peaks was less in this case, the number of them was nearly the same, and the gaps representing periods when no current was used gave, on being added up, 45 per cent. of the total. Thus for nearly half the time the car was running by momentum alone. It must be remembered that every few hundred yards there is a street, crossing those we ran on, and all these streets have their tramways; so that for common safety it was necessary to slacken down at each square or block of buildings, even when other traffic and passengers did not impede our progress. These diagrams teach us two important lessons; one is, that a skillful driver can economize energy to a large extent; the other, that proper appliances for regulating the power within a wide range are a distinct advantage.

After a good shower of rain the tram rails assume a tolerably clean appearance; the mud is then easily squeezed out by the flanges of the car wheels. Thus I have observed that during or immediately after a rainfall, the energy necessary for propelling a vehicle is considerably less than in dry weather. There is a positive saving of power amounting to from 15 to 50 per cent. with clean wet rails. By careful observations we were enabled to record the effect of various comparatively small obstacles on the rails, the ammeter showing the minutest variations in tractive force; it is far more trustworthy than a dynamometer, since it has neither friction nor momentum.

Snow is the greatest enemy of tramways. It offers the greatest resistance to traction. Anticipating snow storms which occur rather frequently in some parts of the States, we fitted the experimental car with a snow plow and wire brushes. The plow shares were supported by a balanced frame underneath the front platform of the car. These shares could be raised and lowered by foot pressure. Behind the plow shares, and just ahead of the front wheels of the car, were brushes made of steel wire, and these were kept scraping over the rails by their own weight. The plow served the purpose of removing the bulk of the snow, and the brushes swept the rails and grooves clean in front of the wheel flanges. One day, when it snowed very hard, and when the rails were covered about a quarter of an inch deep, we ran the car out upon the experimental track, using in the first instance merely the wire brushes and a little sand on the steepest gradient. It took two minutes and eight seconds to run once round the track, which was soon cleared of snow, taking a mean current of 50 ampères. Snow fell hard all the time, yet it required only 35 minutes to make 20 successive trips, with an average of 30 ampères. In the course of four hours the snow was nearly two inches deep, when the car was again started. The brushes alone were of no avail, and the snow plow had to be appplied. The first journey was made in 2 minutes and 20 seconds, but with the enormous expenditure of 80 ampères; each succeeding trip, however, took less time and energy, until it reached nearly to its normal value, corresponding to clean rails. This would show that with proper appliances, and with cars rapidly succeeding each other, the track can be kept clear; but the accumulation of much snow in the first instance occasions a fearful demand of energy, and without plow and brushes the snow is compressed by the wheels and renders progress almost impossible.

Recent tests made by a commission on the Frankfurt-Offenbach Electric Tramway, which has been in constant operation for six years, gave the following results: Two cars, one of which contained the motor, the other an ordinary car attached to it, were taken over the line. The motor car weighed four tons, the ordinary car two tons, and 20 passengers 1½ tons, giving a total of 7½ tons. Measurements with an ampèremeter were made every five seconds. The electromotive force varied between 240 and 300 volts. At starting the current used was 80 to 100 ampères, which fell to 40 in 10 seconds, and the mean current on the level road at eight miles an hour fluctuated between 15 and 25 ampères. On a gradient of 2.85 per cent. 55 to 60 ampères were recordcd, and the mean current over a distance of one mile, occupying seven minutes, was found to be 21.48 ampères, and this included four stoppages. The highest amount of energy recorded at any moment, when starting, was 21,700 watts.

Dr. Louis Bell, in an interesting paper published a few months ago, gave the results of his experiments on the La Fayette road (Ind.), from which I take the following instructive figures. Experimental runs were made on a level road with a car and passengers weighing together 8,200 pounds.

Miles per hour.	Volts.	Ampères.	Electrical h. p.
7.5	404	9.5	5.15
9.3	416	10.4	5.79
9.1	393	10.7	5.40
10 9	434	16.1	9.35
12.4	433	15.4	8.93

Another test on a gradient of 6.58 per cent. rise, one-tenth of a mile in length, gave the following results:

Miles per hour.	Volts.	Ampères.	Electrical h. p.
2.73	317	27.2	12.65
4.20	403	27.4	13.17
9.30	409	31.3	17.14
6.20	365	32.4	15.85

These results are remarkable when compared with those on the level road. Considering the steep gradient, one would have expected a much larger consumption of energy at the necessarily low motor speed. On the other hand the tractive force on the level road appears to be abnormally high at all speeds when the motor efficiency should be at its very best.

More recently Mr. O. T. Crosby published some interesting data concerning three American tramways which, like those of La Fayette, were worked by overhead conductors. The average expenditure of energy on one car on each of the following lines was:

	Watts.	Electrical h. p.	Load.	Average speed.
Richmond	4,883	6 5	8,500	6 miles
Cleveland	4,986	6.6	9,500	9 "
Scranton	5,587	7.4	9,500	5.7 "

The maximum gradients were given to be at Richmond nine per cent.; at Cleveland "very slight," and at Scranton seven per cent., involving maximum expenditures of power of 25.6 h. p., 15 h. p. and 19.2 h. p. (electrical measurements on cars), respectively.

Dr. E. Hopkinson ascertained the mean tractive force on the Bessbrook-Newry Tramway, and he showed that it amounted to 28.9, 27.4 and 37.1 pounds per ton of gross load hauled during three journeys. The increase in the third journey is due to the mean speed having been nearly doubled. The gradients are not severe in this case, but continuous in one direction.

From numerous sources at our disposal we find that the mean tractive force may be anything from 30 to 50 pounds per ton, and that it is seldom, if ever, below 20 pounds on level roads excepting under very favorable circumstances.

All these figures point to the fact that the mechanical resistances on existing tramways are very great, and that even a slight reduction at a comparatively small cost would bring about a considerable saving in traction expenses. By reducing these resistances we not only save power with existing appliances, but by virtue of a smaller demand of tractive force we are enabled to utilize lighter motors, lighter gearing, lighter storage batteries, which, in their turn, again require less for their own propulsion until a practical limit is reached.

Assuming, *a priori*, high efficiency in electric motors and gearing, improvements as regards mechanical resistance on tramways may be looked for, and, I hope, attempted in the following points:

1. Solid, well fixed, parallel rails.
2. Perfect cylindrical wheels, with thin flanges, or some of them without flanges.
3. Clean rails. The grooves may be swept and watered several times a day by a vehicle especially fitted for this purpose.
4. Sufficient flexibility in axle boxes to allow of free movement in curves.
5. A reasonable number of graduations in the motive power regulated by a switch.
6. Skillful driving, which should occasionally be proved by careful tests and power curves.
7. Automatic sand boxes on steep gradients where the natural adhesion is insufficient.

In conclusion, I will repeat that a frequent and judicious use of the ammeter on electric cars will amply repay you for the trouble; it will be the means of great improvements, in the same manner as the indicator diagram, which enabled us to study the nature of steam engines, and has been the most direct means of effecting great economy in working.

Automatic Electric Welding Machines.*

BY HERMANN LEMP.

Among the latest achievements in electrotechnics stands prominently Prof. Thomson's electric welding process. The broad underlying principle has so often been described and exhibited by its able discoverer and others that to repeat it would be imposing upon your patience. The evolution of a new process and its reduction to practice for commercial purposes, especially if the leading elements of its working are novel in themselves, must necessarily open a vast field for investigation. Such is the case with electric welding, and with a view of showing the commercial apparatus of to-day, it will be necessary for me to state the electrical and mechanical requirements that led to its construction.

The reason for which machines have been invented, has been for the purpose of reproducing faithfully and constantly a set of conditions necessary to obtain a certain result. When the conditions in any case are few and the product simple, generally one design of machine will be sufficient. With an increased number of conditions, however, the complexity of the apparatus increases rapidly and demands, in many cases, subdivision into different processes to be executed by separate machinery. What constitutes skill, in a working man, for instance, is the ability co-ordinately to reproduce a number of operations or movements; to be, in other words, a perfect machine, or to produce the same result even if other conditions than those previously contemplated should arise.

To secure uniform results in the practice of a difficult operation, there are two ways possible.

1. To employ skilled help for the complex portion of the work alone.

2. To substitute for the more complex portion of the operation, one more readily controlled.

The ordinary welding process requires the greatest skill at the hands of the blacksmith for heating the metals to the proper temperature and at the right spot, while preventing the accumulation of cinder or scale. While skill may be successful with metals of high melting points and low conductivity for heat, easily fusible metals and especially good conductors baffle all attempts as long as an exterior heating source is employed.

The electric welding process has, as you know, not only made it possible that operators not particularly skilled in the art of blacksmithing can produce good substantial welds, but has created an art equally adaptable to all metals and combination of metals.

The following are all the metals, alloys and combinations so far actually welded with success by the Thomson process:

METALS.

Wro't iron,	Cast copper,	Antimony,	Aluminum,	Manganese,
Cast iron,	Lead,	Cobalt,	Silver,	Magnesium.
Mall. iron,	Tin,	Nickle,	Platinum,	
Wro't copper,	Zinc,	bismuth,	Gold (pure),	

ALLOYS.

Various grades of tool steel.	Cast brass,	Aluminum bronze,
Various grades of mild steel,	Gun metal,	Phosphor bronze,
Steel castings,	Brass composition,	Silicon bronze,
Chrome steel,	Fuse metal,	Coin silver,
Musshet steel,	Type metal,	Various grades of gold.
Stubs steel,	Solder metal,	
Crescent steel,	German silver,	
Bessemer steel,	Aluminum alloyed with iron,	
	Aluminum brass.	

COMBINATIONS.

Copper to brass,	Brass to tin,	Silver to platinum,
Copper to wrought iron,	Brass to mild steel,	Wrought iron to musshet steel,
Copper to German silver,	Wrought iron to cast iron,	Wrought iron to stub steel,
Copper to gold,	Wrought iron to cast steel,	Wrought iron to crescent steel,
Copper to silver,	Wrought iron to mild steel,	Wrought iron to cast brass,
Brass to wrought iron,	Wrought iron to tool steel,	Wrought iron to German silver,
Brass to cast iron,	Gold to German silver,	Wrought iron to nickel,
Tin to zinc,	Gold to silver,	Tin to lead.
Tin to brass,	Gold to platinum,	
Brass to German silver,		

But Prof. Thomson was not satisfied with this progress made above ordinary welding; he early recognized the importance of a machine in which all conditions for successful operations are mechanically controlled to produce uniform results, work rapidly and require little or no attendance.

Such machines, now known as automatic welding machines, have proved to be of special importance in connection with easily fusible metals, enabling the successful welding of aluminum, silicon and aluminum-bronze, which require even with the electric process a considerable skill.

Before entering into a detailed description of the automatic welder, a few general data on welding will be in order.

The Thomson process of electric welding can be and has been worked by means of continuous or alternating currents; secondary batteries or unipolar machines may be and have been used. There are such conditions as transportability, absence of motive power, situation in continuous distribution district, etc., which may make it advisable to use the continuous current. The alternating currents, however, have so far been found the best adapted to be economically produced of large volume at low E. M. F. They are easily and economically controlled, and allow of being distributed at high pressure with small conductors, and of being reduced to working pressure wherever needed. They have, however, another beneficial effect, which is of importance in all welds of large sections.

It is a well-known fact among manufacturers of incandescent lamp filaments of large section that the inner portion in a filament is apt to be overheated. In treating

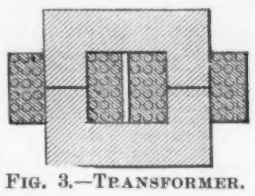


FIG. 3.—TRANSFORMER.

filaments as used in the commercial series lamp, in hydrocarbon atmosphere, the writer once thought of producing a specially good quality of carbon by starting with an extremely thin, base .004 inch thick, and obtaining a filament 90 to 95 per cent. of which consisted of hard, gray, lustrous carbon. His idea was also to extend this process to the manufacture of arc light carbons, and even produce pencils of about ¼ inch diameter. What was his surprise, however, to find that although the lustrous surface presented at all times a dense gray structure, the core lost this character after a certain thickness of carbon had been deposited. In fact, a number of concentric layers would be discovered, from the inmost graphite to the dense gray, semi-crystalline at the outside.

This action can in my mind only be attributed to the over-heating of the carbon particles in the inside. A similar action takes place in a bar of iron if heated by an electric current. The surface exposed to radiation will be at a lower temperature than the core. It is true that the heating of the metal will increase its resistance and thus tend to equalize the temperature, but not enough in all cases. By the use of alternating currents we gain, however, an assistance in the self-induction. The effect of the latter is especially marked, and has a tendency to concentrate the heat on the surface.

If there is any place that receives more current than another, the effect of the self-induction is emphasized by the fact that the surrounding part is cool and its permeability is greater than the part traversed by the surplus of current. With very large and especially wide metal pieces the unevenness of distribution may be remedied by approaching iron masses to create at a given spot a greater self-induction or counter E. M. F., thus diverging the current from that section. Prof. Thomson has early recognized the importance of, and has patented, a device to prevent

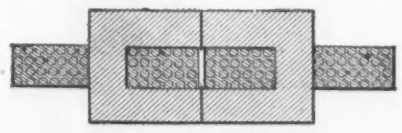


FIG. 4.—TRANSFORMER.

the heating of the metal at a given spot by creating locally increased self-induction or magnetic effects.

In view of this, an experiment almost daily witnessed by us, it is interesting to note the paper controversy between parties disputing the priority of a device that is to produce exactly the opposite result with, however, the same means and conditions.

Two methods of distribution are in use, the direct and the indirect. In the former an alternating current dynamo is used, having two windings on the armature, one of which furnishes currents rendered continuous by a commutator to excite the field magnets, and is controlled by switch and rheostat; the other consisting of a single turn of heavy copper cable furnishes the welding current, which is led through collector and brushes to movable copper clamps suitable to receive and guide the welding specimens during the operation.

In some other forms the field magnet is the movable part, in which case no heavy currents have to be carried through collector and brushes. No direct welders are built at present for currents larger than 4,000 amperes.

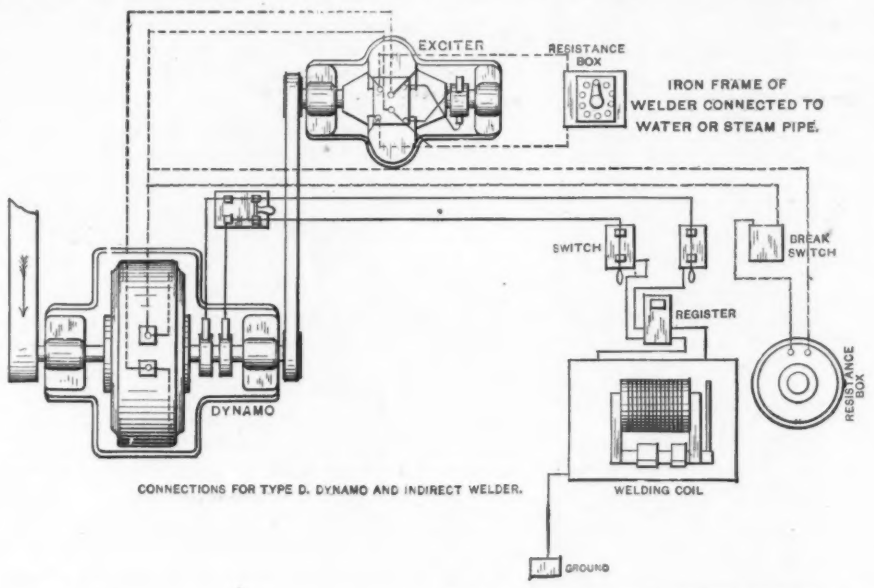
The indirect method of distribution is almost exclusively used to-day. It consists in its simplest form of one alternating current dynamo, self or separately excited, and one welder that is a transformer with the necessary clamping and operating appliances. The self-exciting dynamos used are from 1,000 to 20,000 watts output, and may be regulated by means of a reactive coil to give a varying E. M. F. never to exceed 300 volts.

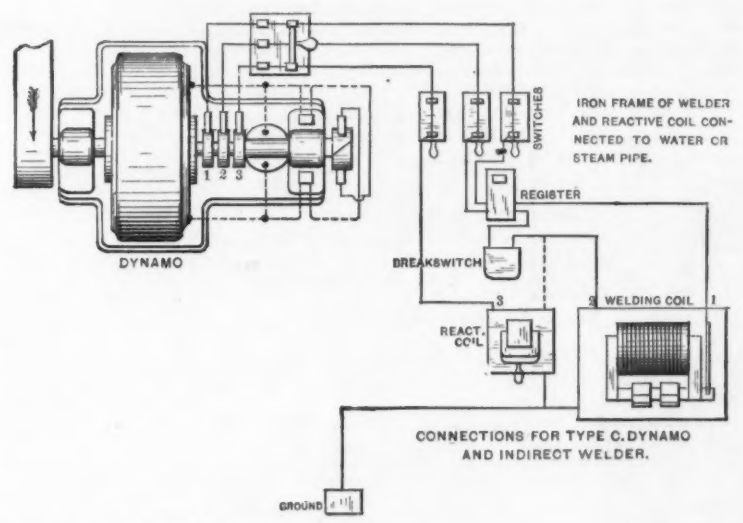
They are substantially built to withstand sudden strains, and have self-oiling bearings: brushes are never to be moved and perfectly sparkless, requiring no other attendance but cleanliness.

The winding on the transformer being once for all set, variation in the E. M. F. has to be obtained either by varying by hand the initial E. M. F. of dynamo or to excite a dynamo to the lowest potential required, it being so compounded as to give with the maximum work the increased E. M. F., or finally to maintain a constant E. M. F. at dynamo under all loads and vary the E. M. F. at the transformer by interposing a variable resistance, or, preferably, self-induction. The transformer itself may be built so as to give a different ratio of conversion, either by moving the primary and secondary relatively to each other or by shunting lines of force by means of an iron bridge between primary and secondary, or by altering the number of turns in primary or secondary by a switch.

When a single plant is used, viz., one dynamo and one welder, it is the dynamo generally which, if separately excited, is regulated by means of a rheostat in the exciter circuit or by a reactive coil in series with exciting coil on armature if self-excited. Fig. 1 shows the connections used with a separately excited machine. The only thing different from similar installations is the break switch, which is operated by a foot treadle and automatically opens the circuit when foot pressure is removed. This prevents any mishaps when operated by unitiated persons, as all action ceases when one leaves the apparatus. The primary voltage never exceeds 300 volts with 100 alternations or 50 complete cycles per second. Nothing but the very best insulation is used in the primary wiring. It is deemed necessary to protect the customers, not only against any shocks, but even against the scare of one, and we recommend to permanently ground the secondary, which in welding apparatus is virtually the table and pressure devices.

Diagram No. 2 shows the connections used for a self-excited composite dynamo, which has two windings on armature, a longer main and shorter exciting coil. Both are wound in the same direction, and currents generated therein pass in multiple commuted through the shunted field magnet; after this through line No. 2, controlled by a break switch and split, one returning through reactive coil and line 3, the other through welder and line 1 to their respective windings. The exciting effects of each circuit add themselves. Reactive coil is conveniently placed near the welder. Dynamo is regulated from minimum to 300 volts, and excited for each weld anew.





FIGS. 1 AND 2.—DIAGRAMS OF ELECTRIC WELDING APPARATUS.

For some work which requires to be done at great speed, the second method is resorted to, that is, to keep the field constantly excited by fixing a variable reactive coil in a given position just enough to produce about 150 volts, the lowest E. M. F. required. The proportion of the field magnets, the E. M. F. of exciting coil and the resistance of a shunt to field, are such as to produce an overcompounding of 100 per cent. in this case with largest current in primary.

This method of regulation is very nice, as it is absolutely automatic, responds quickly, the field of the dynamo not requiring to "build" every time from residual magnetism alone. We sometimes call it "cubic compounding," as it produces a constant heating effect for variable cross sections and variable lengths as well. With this modification the wiring of diagram No. 4 is slightly altered, the break switch breaking only the main circuit leaving the exciting circuit permanently closed.

The methods so far described are only used when a single welding machine is to be operated. It was early recognized that if the process is at all to be used on a commercial basis, that at least the generating of the necessary currents should be limited to as few machines as possible. It required, in other words a dynamo, giving a nearly constant E. M. F. of sufficient capacity to feed a number of welders while maintaining for each absolute independence.

Since all welding for a long while to come will probably be operated in isolated plants, the dynamo is to be placed in the hands of an engineer generally, not an expert in electrical matters, and has, therefore, to be easily attended and free from all the little faults and kinks which are at present the sole consolation of the dynamo tender. One of its prime requirements are close automatic regulation under all loads.

Constant potential, self-regulating dynamos are manufactured in various sizes, and are self-exciting up to 30,000 watts output. Dynamos with larger output are separately excited, but also self-regulating. The methods employed to obtain regulations are novel, and will form the subject of another paper at some future date.

I would simply state that either constant potential or a percental increase with load can be obtained, and that the regulation will respond even if the load consists of self-inductive translating devices.

I lay some stress on the regulation of the dynamo for the reason that the generators are not to be placed in the

*A paper read before the general meeting of the American Institute of Electrical Engineers, Boston, May 21, 1890.

hands of special attendants, as in case of a central station, but have to deliver their currents under constant pressure whatever may be the conditions of work they are subjected to; even an automatic regulator would hardly be able to follow the rapid variation of load.

The following conditions influence the perfection of the work, and are variable with different materials and sizes:

1. Projection of the abutted pieces in the path of the current.
2. E. M. F. of welding current as controlling the strength of current flowing.
3. End pressure applied to force the abutting ends into each other at welding heat.
5. Interruption of current at proper time.

1. The projection of the abutted pieces varies with the diameter. It has been found that for copper, a projection of two times the diameter for each clamp gives the most economical results. With steel and iron, the most economical projection equals the diameter and is for brass one and one-half times the latter.

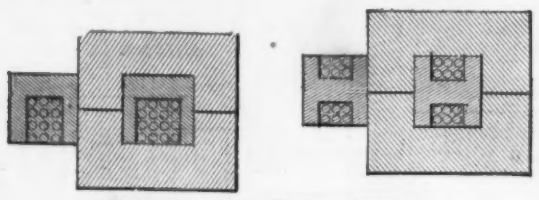
The projections sensibly affect the energy required, and the most economical one depends upon the heat conducting properties and specific resistance of the specimens. Accordingly high conducting bodies require longer projections, highly resistant ones short projections. Conductors of larger and smaller diameters may be welded by giving to each its respective projection. In the same manner may wires of different material be joined to each other.

It is easily understood that since unequal projections on different sized conductors produce the proper heating of both at their junction, equal projection of equal sized conductors will be required. All other conditions neglected, it is important to keep the projection for a given size and material constant.

2. The E. M. F. required depends upon the projection and the resistance of the material to be welded. For larger cross section, the specific self-induction plays an important role, and indirectly the shape of the specimen.

Another factor affecting, the E. M. F. is the resistance between clamps and material and the resistance of copper conductors. The E. M. F. required for iron and steel is nearly double that for copper, and would be four times if equal projection were used for both.

A certain drop of E. M. F. will be found from the clamps to the specimens. This drop is rather low on material having naturally bright surfaces, as, for instance, copper, brass, german silver, tin, or even cold rolled iron and steel. For a large class of work, however, especially in carriage hardware, the surfaces to be used for contracts have a light scale left after passing through the rolls, which has either to be removed by grinding or filing, or to be overcome by the E. M. F. of the current. In a good many cases, the introduction of a special process of cleaning is deemed to be more expensive than to use a little extra power to work through the scales.



Figs. 5 and 6.—Transformers.

3. For uniformity of result the end pressure required to press the abutting specimens into each other at welding heat is of more importance than any of the former agencies; this is, in fact, the one which controls and rectifies any inaccuracies in the former conditions. If the pressure necessary for a given size and material is used, the weld cannot be performed until the metal has acquired the necessary plasticity to yield to the pressure. If for one reason or another, the E. M. F. and, consequently, the current should have been too strong, the time necessary for welding alone is affected, and in this case shortened. The bars will, however, be united at the same temperature and with the same force, whatever the time may have been used to bring about the plasticity necessary. The pressure will in some respects influence the heat by forcing the metals into each other at either higher or lower temperature, and by so doing cause the action to be interrupted at an earlier or later period, as may be required.

The pressure required varies with the material and is approximately 1,800 pounds per square inch for steel, 1,200 pounds per square inch of iron, 600 pounds per square inch of copper. It varies also with the area of cross section, as indicated by its being expressed a function with the surface as one of the factors.

4. The interruption of the current as soon as the weld is completed is important for all easily fusible metals. When two copper wires are welded together, the welded portion being increased in cross section owing to the end pressure, if the current is not interrupted a large portion of the conductor on either side of the weld, including the latter, becomes heated and will melt and be torn asunder before any pressure device could follow and over bridge the gap.

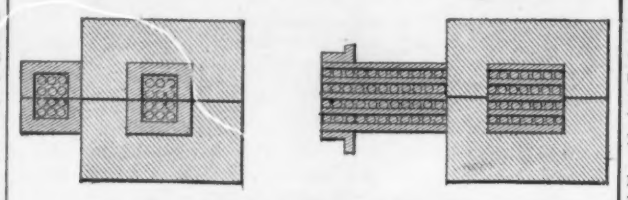
The current should, therefore, be interrupted as soon as the weld is completed. It is also sometimes required that the parts to be welded should be of a certain predetermined length, in which case the interruption of the current as soon as the allowable distance has been reached is essential.

All these conditions are maintained constant in the automatic welder before us, which is the first commercial type of its kind. This welder is not entirely automatic in the strict sense of the word. The degree of automatic action has to be considered for each individual object separately. This machine contains, however, the leading features as covered by Professor Thomson's patent, June 26, 1888, No. 385,022, with a few improvements in mechanical construction. The capacity of the machine is nominally copper wire No. 6 to No. 17 A. G. It will, however, weld larger and smaller sizes. It weighs 130 pounds complete; the secondary is one solid copper casting of a cross section resembling a hollow square box with one of the sides removed.

This casting is firmly screwed to an iron table. A saw cut at right angles to the plane of loop creates the two poles one insulated from the table, and the other constituting a V-shaped bearing suitable to receive a sliding clamping device.

The hollow part of the secondary is to receive the primary coil which is separately wound in a form and insulated with special care. Two U-shaped laminated iron cores embrace primary and secondary.

It has been found that the best form of transformer is the one in which the primary and secondary coils are coaxially placed on an iron core, so as to oblige all lines of force generated by the former to cut through the latter. If the two windings are placed side by side on an iron core or on opposite legs, as shown in sketch No. 3, there is a tendency to form consequent poles at the point where the two windings meet, due to the leakage of lines of force. The leakage will depend upon the distance beeween the two legs aud upon the length of magnetic circuit. It has been purposely increased and turned to advantage by Professor Thomson, for obtaining constant current in the secondary while the primary is supplied with constant E. M. F., Fig. 4. When, however, constant E. M. F. in secondary is required it is important that this leakage should be decreased to a minimum.



Figs. 7 and 8.—Transformers.

Various forms of secondary may be employed to work consistent with the above principle. A few of these are shown in diagrams Nos. 5, 6, 7 and 8, in which cases the secondary is preferably a solid copper casting. Forms shown in Figs. 8 and 9, however, permit hard rolled copper plates to be used.

For mechanical reasons and convenience, forms No. 5 and 6 are mostly used, and actual experience shows practically no leakage. This construction permits of removing the primary without disturbing the secondary in the least It also gives the least possible self-induction for a given cross section.

It is often found stated that when large quantities of alternating currents have to be conveyed through copper conductors, it is important to have the same laminated or subdivided in smaller conductors to reduce self-induction. This may be true to a certain extent. The shape of cross section is, however, far more important than the lamination.

An experimental compound conductor, consisting of a number of flat copper ribbons in parallel showed a self induction of *three* when the ribbons were closely packed, of *two* when separated into two parts, and *one* when spread open like a fan.

The explanation for this was given to the Institute last year by Professor Thomson, when he showed self-induction to depend mostly upon the length of the lines of force surrounding a conductor when traversed by intermittent or alternating currents.

Returning to the subject before us we find that the pole which is insulated from the table constitutes the stationary clamp. The uninsulated pole, which is considerably larger, has on its upper side a long V shaped groove parallel with the axis of the secondary, Fig. 10. A movable copper block, also V shaped, fits in the bearing, and can be slid in the same forward and backward.

This movable block carries the second clamp. The current necessary for welding has to pass through this sliding contact. The welding of small copper wire, or any other easily fusible metal, is a very difficult thing, if special apparatus is not used. The current required is very large, several hundred ampères for wire not larger than No. 17 A. G.

The metal when it reaches welding heat readily melts away, and has to be followed by the movable clamp so as to prevent the breaking of the circuit. This latter action when it occurs is so violent that a special device is necessary to prevent injury to the coil in case of such a rupture. The movable clamp, in order to follow the softening of the metal, has, therefore, to have as little friction as possible, and yet has to make a good contact to carry the heavy currents. The clamp is furthermore required to move in true guides so as to abutt the small conductors with their axes in line. The heating necessarily brought about when rapid and continuous welding is done must not interfere with the bearing and cause the carriage to stick through expansion.

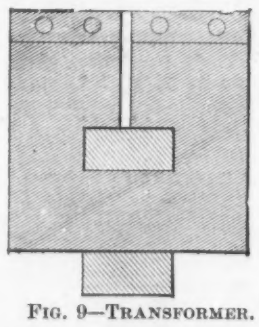


Fig. 9—Transformer.

All these conditions have been complied with in using the V bearings, the carriage being held down in contact by means of a heavy spring, and a number of copper rollers being interposed between the carriage and the bearing, Fig. 10. The copper rollers are simple, short pieces of ¼-inch hard rolled copper wire rounded at the ends. There are 16 altogether, eight toward the front and eight toward the back of carriage equally distributed on both sides of the bearing.

A stationary rod at apex of bearing prevents the interference of the two rows of rollers. Between the two sets of rollers in front and in back a bolt passes applying the spring pressure, forcing the carriage into contact with the bearing. A pressure of 40 pounds may be employed and yet the carriage will move freely. These sixteen rollers have to transmit a current of approximately 3,000 ampères. They absorb about 20 per cent. of the total energy, which loss is, however, fully balanced by the reliability and simplicity of the device. This loss is, moreover, only on the maximum sizes and becomes insignificant on small work.

An adjustable coiled spring pulls the sliding clamp toward the stationary one. In front and pivoted on a lever is the distance gauge, which may be inserted between the two clamps. This gauge carries on a central disc a number of steel pins of varying lengths, but equal projection on either side of disc. These projections, if inserted between the two clamps, give the necessary distance required for a given size wire, the disc against which the wires are abutted insuring equal projection of both ends to be joined. On the back of the apparatus a switch is located in the primary circuit, which is normally held open by a spring. By moving the handle to the right the primary will be closed and the switch locked by a little catch underneath the table. A pin fastened to movable clamp will lift the catch and release the switch, thus opening the circuit.

An intermediate lever between catch and pin operated by a sliding rule, which serves also as an index, permits of varying the point of cut-off, which has to be in a certain relation to the distance between clamps. The position of cut-off tension of spring, distance between clamps corresponding to each other, are marked with the same figure, which is also inscribed on a wire gauge fastened to the welder. By inserting a wire into the gauge the number read will give the necessary adjustments at once.

If, by imprudence, the switch should be moved to the right while no stock is inserted and the clamps in contact with each other, the switch cannot be locked and the fuse in primary will be blown without, however, causing any damage.

The insertion of the distance gauge between clamps locks the switch so that primary can only be closed after withdrawing the gauge.

The operation is as follows:

1. The wires to be welded are gauged.
2. The distance gauge and cut off are set to correspond with number on gauge.
3. The movable clamp is moved to the right and gauge inserted.
4. Both wires are securely clamped, care being taken to abutt the ends squarely against the disc.
5. The gauge is withdrawn.
6. The switch is moved to the right.
7. The reactive coil moved toward a position of minimum reaction, and restored to maximum after weld has been completed.

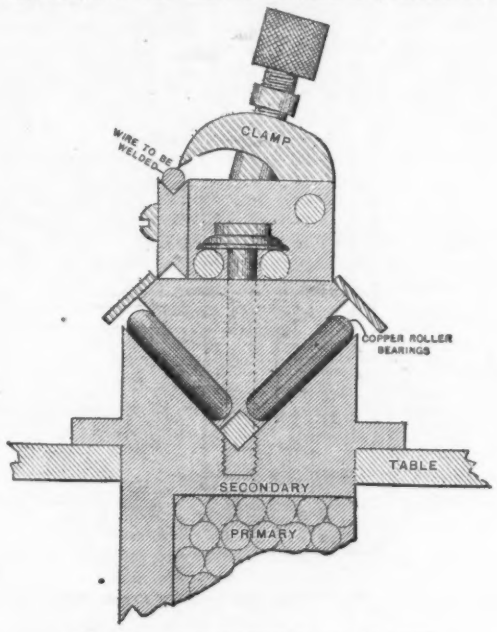


Fig. 10.—Arrangement of Clamps.

8. The clamps are opened and the weld removed, after which the operation can be repeated again.

If a good many welds of the same size material are to be made, the reactive coil may once for all be set in a given position and the switch alone be operated.

Welds made with the automatic machine have attained an uniformity not obtainable with very skilled operators working without it. In fact, small, easily fusible wires can scarcely be welded with certainty with ordinary apparatus. For aluminum especially the automatic apparatus is needed.

The reactive device used in connection with welders is the type recently described by Professor Thomson, in which a cast is made to more or less cover the primary, the self-induction of which is to be altered. To obtain still a larger range, the windings of primary can be coupled in series, or multiple series, or multiple, by a switch in base of coil.

As mentioned before, the welding of easily fusible metals may sometimes cause a rupture of the secondary circuits, which, owing to its violence and volume of energy, may cause a burn-out of the primary if not guarded against. This danger is not very great in the automatic machine, since the end pressure does not depend upon the attentions of the operator. A special device is, however, used as an extra precaution against all emergencies.

Breaking a high-tension circuit rapidly is not easily done. An arc generally follows the break, and this lengthens the time of the rupture If the voltage of the circuit to be broken is so low that over the slightest distance an arc cannot follow, the break will be instantaneous. This is the case with the secondary circuit of welding transformer. The voltage, being ordinarily only one volt, would, even if increased tenfold, not be able to maintain an arc. However, multiplied in the primary, it will cause E. M. F. sufficient to pierce through the insulation as ordinarily used. This action is similar to a Rhumkorff coil in which the interrupter is caused to break under oil or water.

This discharge is taken care of by a special apparatus, the description of which I reserve also for another communication to the Institute.

While the machine before us is only one type embodying the principal features contained in all, others have been manufactured, or are in process of construction, in which the automatic character has been carried out even further, as in the welding of rings and chains. I am not permitted to give a detailed account of these latter at the present time, but would say that the present model in its first form is able to produce 250 feet of chain in a day without any attendance to speak of, the plain wire being fed into the machine at one end and the complete chain coming out at the other.

The automatic principle is, however, not confined to small conductors. We have welders with 40,000 Watts output, capable of welding 1″ copper or 2″ iron, con-

structed and working daily on that plan. The projections are determined by adjustable stops, the pressure, the most important of all, is hydraulic and regulated by an automatic reducing valve, the exhaust being used for cooling clamps at the same time. The primary is controlled by adjustable reactive coils from a constant potential circuit and is interrupted at the proper time by the clamps. While not all machines to-day are operated on this plan, I am convinced that the evolution of the welding process tends in that direction, and that the welding in future will be in the full sense of the word a purely mechanical operation This cherished idea of Prof. Thomson's, uttered a few years ago, has well been borne out by the experience gained in actual operation on a commercial basis.

The Electric Current as a Traction Increaser.

BY ELIAS E. RIES.

Within the past three or four months a number of articles have been published in the electrical journals purporting to show, some theoretically and others by experiment, that the passage of an electric current between a driving wheel and rail could have no effect in increasing the traction or coefficient of friction between the two surfaces in contact, and that if the current had any influence at all upon the friction it could only act to reduce the traction instead of increasing it.

As the writer was probably the first to call general attention to the importance of increasing tractive adhesion by the direct action of the electric current, and the first to point out the laws bearing upon this subject, as determined by experiments made by him several years ago for that purpose, it seems fitting that he should reply to these articles.

It appears to have been taken for granted by many persons, probably because the phenomena of increased traction were first observed in the operation of electric railway motors, that the mere use of the track rails as the return conductor in an electric railway system is all that is necessary in order to insure increased adhesion between the motor wheels and the rails. This is by no means the case, as the result is entirely dependent upon the nature of the current employed and the circumstances under which it is permitted to act.

As a matter of fact, the conditions existing on single-trolley railways, as at present operated, are not such as to be favorable to the production of increased traction, and although a certain amount of increase in adhesion occasionally manifests itself, it is not such as to be relied upon with any regularity or certainty, and is due, as will hereinafter appear, to causes entirely different from those that produce increased traction in cases where a local or independent traction circuit moving with the vehicle is employed, such as embodied in the method of electrically increasing traction devised by the writer.

In my original paper upon this subject, read before the American Association for the Advancement of Science in August, 1887,* the underlying principles and conditions governing the production of increased friction by the action of the electric current were set forth for the first time in the following paragraph:

"Before entering into a description of the means by which this result is produced, and how it is proposed to apply this method practically to railway and other purposes, it may be well to give a general outline of what has so far been determined. These experiments have shown that the coefficient of friction between two conducting surfaces is very much increased by the passage therethrough of an electric current of *low electromotive force and large volume*, and this is especially noticeable between two *rolling* surfaces in peripheral contact with each other, or between a rolling and a stationary surface, as in the case of a driving wheel running upon a railway rail. This effect increases with the *number of ampères of current* flowing through the circuit of which the two surfaces form part, and does not materially depend upon the electromotive force, so long as the latter is sufficient to overcome the electrical resistance of the circuit. This increase in frictional adhesion is principally noticeable in *iron and steel*, although present in other metallic bodies, and is due to a molecular change in the conducting substances at their point of contact (which is also the point of greatest electrical resistance in the circuit), *caused by the heat developed at that point*. . . . The most economical and efficient results have been obtained by the employment of a transformed alternating current of *extremely low electromotive force, but of very large volume or quantity*, this latter being *variable at will*, so as to obtain different degrees of frictional resistance.

The correctness of the principles originally set forth in the above paragraph have been repeatedly substantiated by subsequent experiments, and it will be seen therefrom that, in order to produce increased traction by the direct action of the electric current, the following conditions must be observed:

1. The current must be of such volume as to produce an appreciable amount of heat at the point or points in contact.

2. The electromotive force must be as low as possible. Experiments made by the writer have shown that a high electromotive force has a tendency to *diminish* friction, especially if the pressure between the surfaces in contact is a moderate one.

3. The metals in contact should be of iron or steel, as these have the requisite electrical resistance at their contact surfaces and are of such molecular structure as to permit of a close and intimate union between them under the influence of the current.

4. One or both of the metals should preferably roll upon the surface of the other. This is desirable in the first place, in order to economize current by concentrating the heating effect upon as narrow a line of contact as possible. Furthermore, a rolling motion, where the line of contact moves progressively and uniformly along both surfaces, as in the case of a wheel and rail, where the contact is continually established at new points, requires less current to produce a given tractive effect than in case of sliding friction, where the surfaces move at different rates of speed, and are never in fixed relation to each other for an appreciable length of time.

Let us now see whether or not these conditions have been fulfilled by those who have endeavored to show that the electric current is incapable of increasing tractive adhesion. We will then look at the matter from a more practical standpoint, and show what the electric current has done, and is capable of doing, in this direction, when properly applied.

Prof. Lucian I. Blake, in a paper recently read before the Kansas Academy of Science, describes and illustrates a number of experiments stated to have been made for the purpose of determining whether an electric current would, as stated, increase the friction between a wheel and rail in electric railways. Four different experiments are described, not one of which even *approaches* the conditions met with in railway practice. In two of these experiments such metals as platinum immersed in flowing mercury and a brass bar sliding upon brass rails were employed! The flat surfaces in frictional contact "varied from 1½ to 3 square inches," an amount several times greater than the combined effective area of contact of four ordinary railway-car wheels, while the current sent through these surfaces was several times less than that ordinarily used in railway practice, being but 1 ampère and 10 ampères respectively! The two remaining experiments illustrated a case of rolling or skidding friction in which the current used was presumably the same as in the first experiment, "varying from 0 to 1 ampère." In short, these experiments seem to have been devised for the express purpose of showing "how *not* to do it," since Prof. Blake himself admits in concluding that "the currents employed were not sufficient to produce heating at the surfaces of contact," and adds that "such heating would doubtless produce an increase of the coefficient of friction."

Mr. O. T. Crosby has also described some dynamometer tests tending to show that no increase in traction occurs. These tests were made by him with an ordinary single trolley motor car, and consisted in first returning the motor-operating current through the wheels and rails in the usual manner, and then repeating the experiments with the wheels out of circuit. The current employed was varied from 0 to 42 amperes during the experiments, and the electromotive force, though not stated, was probably 500 volts. Unfortunately, the capacity of the dynamometer at Mr. Crosby's disposal was less than that needed to register the ordinary tractive effort of the car on a level track, and he found it necessary to jack up one end of the car so as to *skid* only one pair of wheels and to relieve these of a part of their weight It will be apparent from what has been said that the conditions under which these tests were made were not only unfavorable to the production of increased traction, but were of such a nature as to bring about the very opposite result.

There seems to be an impression among many persons that the increased traction, if present, must be due in some way to magnetic action. This view of the matter has been taken by Mr. Nelson W. Perry, of Cincinnati, who endeavors to show that no appreciable increase in traction can result from the direct passage of an electric current from wheel to rail, or *vice versa*, because there would not be sufficient "*attractive*" force produced. It is further stated that the passage of current in this manner could only result in a repellant action between the metals in contact, the author citing, among other things, the action of the electro-motograph in support of his views, and in general denying that increased traction could result by reason of *any* change, molecular or otherwise, caused in the surface of the metals by the action of an electric current, notwithstanding the fact that elsewhere in his communication he admits having witnessed an experimental demonstration in which the current *did* have the effect which he endeavors to prove it *could not* have. It is needless to state that there is not the slightest basis for any of the theoretical conclusions referred to, which probably arise from a misconception of the real actions to which the increased adhesion is due.

We will now consider the part the current plays in the production of increased traction. It has already been said that this phenomenon is directly due to the *heating effect* of the current upon the metals at their point of contact. A certain slight magnetic effect is necessarily also present, but this is so small in the case under consideration that it does not enter to any appreciable extent into the result, and may therefore be neglected. This heating produces a molecular change in the surfaces of the metals which causes a variation in the coefficient of friction between them, but the nature of this variation and the manner in which the increased adhesion is produced depends upon the nature of the metals and the degree of heat developed at their points of contact. As an illustration of this it may be stated that a moderate current of sufficient strength to cause increased adhesion between iron or steel surfaces will have a lubricating effect upon brass contacts and cause a diminution of the normal friction between them, although with a sufficiently large current the friction may be increased.

Experiments have shown that in the case of iron and steel a comparatively slight amount of heat will serve to increase the friction to an appreciable extent, this being due to a slight expansion and elevation of the metal at one or both sides of the normal line of contact. This action is practically spontaneous, the heating effect taking place on the *surfaces* of the metals long before the body of the latter have had time to become sensibly warm. That the particular effect here referred to is due principally, if not entirely, to the heat, and not to the current directly, is proven by experiments made by the writer with a small electric railway model, in which the increased friction continued an appreciable length of time *after* the traction current had been cut off, the wheels of the motor car having been previously heated by the current so as to retain for a time a portion of the heat imparted to them.

The friction between driving wheels and rails is considerably increased beyond this point, however, by increasing the current strength so as to produce a still greater local heating of the metals at the point of contact, and this is the method preferred by the writer, and most economically carried out by the use of a closed traction-increasing circuit of low resistance, moving with the vehicle and including the driving wheels and that portion only of the track rails that lie between them. When the current strength is sufficiently augmented the increased traction becomes due to an *incipient welding* of the metals along the line of contact. This action leaves no permanent trace upon the wheels or rails, nor is there any appreciable increase in rolling resistance noticeable. The writer has even increased the current strength so as to produce an actual weld between the wheels and rails, without material injury to either of the rolling surfaces; in some experiments, on overcoming inertia, the metals separating again on the line of the weld, the film of oxide between them. By the employment of a converted alternating current of high periodicity with respect to its volume the heating effect may be confined to the surface of the rails without penetrating into the interior. As a rule, the amount of current needed to produce a given increase in traction is found to be proportionate to the area of the surfaces in contact and, to a certain extent, to the speed of the driving wheels. The conditions under which increased traction is called for in practice are favorable to the use of a comparatively small amount of electrical energy for this purpose, since it is only in starting heavy loads and in ascending grades, when the rate of speed is much below the normal, that increased adhesion is usually required.

The writer has recently had occasion to construct a small electric motor car and track with which a number of important facts bearing upon this subject have been satisfactorily illustrated. This model is still in existence and may be seen in successful operation at the writer's office, room 27, Chamber of Commerce Building, Baltimore, at any time. The apparatus in question consists of a small electric railway car having two driving axles insulated from each other and operated by a small electric motor supplied with current through flexible conductors in circuit with a single cell of secondary battery. The driving axles are arranged so that one of several sets of iron or steel driving wheels of different diameters can be placed thereon. The traction increasing current is derived from an independent source and is varied according to the requirements of the experiment in hand. This current, by means of a second pair of flexible conductors connecting with binding posts on the car, is sent from the forward to the rear driving axles through the intervening driving wheels and track rails, although the arrangement is such that it can be sent directly from one rail to the other across the wheels and axles, thus enabling the terminals of the traction circuit conductors to be attached to the rails at one end of the track instead of being carried by the motor. The weight upon the driving wheels without extra load is about three pounds.

With this apparatus, employing a continuous traction-increasing current derived from one cell of secondary battery, the tractive effect of the motor car was increased considerably over 150 per cent., the car climbing grades of thirty feet to the hundred with perfect ease against the pressure of a spring tending to pull it backward; whereas, with the same propelling current flowing through the motor, but with the traction circuit open, the car remained spinning at the bottom of a 10 per cent. grade, not having sufficient tractive adhesion to lift its own weight. Upon again closing the traction circuit the car instantly regained its grip upon the rails and shot up the incline until its further upward progress was stopped by the distended spring and cord that secured the car to a post at the lower end of the track and prevented it from running over the top of the incline. No sparking, flashing or other visible indication that current was passing between the wheels and rails could be observed in this experiment.

There is no mistaking the action of the motor, or the important part the current plays in increasing tractive adhesion. If, while the car is ascending a steep grade, the traction-increasing circuit be opened and then again closed, the car will commence to slip backward and continue doing so with accelerated speed until the moment the circuit is completed, whereupon its descent will be almost instantly checked, and it will promptly proceed to mount the grade again as if nothing had happened.

Among other things, it was shown by this apparatus, as originally predicted, that the traction is not diminished, but (compared with mechanical traction under like conditions) enormously increased when the rails are wet or slippery. The presence of water on the rails seemed to make no difference in traction while the current was passing. With the rails and wheel tires thoroughly *oiled* the car remained stationary with the motor running at the bottom of a 6 per cent. grade. One end of the track was then elevated to form a 25 per cent. grade, and on closing the traction circuit the little car actually climbed up the slippery track as far as the spring would permit without a single idle revolution of the driving wheels!

On increasing the traction current by connecting a second cell in series with the first, so as to produce a perceptible and progressive incipient welding between one or more of the wheels and rails, the tractive pull of the car on a level track, as measured by a standard spring balance dynamometer, was rapidly increased from six ounces, the normal pull without traction current, to 31 ounces with the current, *an increase of over 500 per cent!* Were it not for the fact that at this point the load and the tractive adhesion exceeded the maximum power developed by the little motor, the increased traction actually registered would have been much greater. With the same current passing between the wheels and rails the car performed the remarkable feat of ascending without any slip a 50 *per cent. grade, part of which was coated with oil!* This experiment has since been witnessed by a number of prominent electricians and engineers, who expressed themselves as astonished beyond measure at the wonderful increase in friction obtained, and the comparatively small amount of electrical energy required to produce it.*

In order to determine some of the conditions bearing upon the application of this system of increasing traction to ordinary railway train service, a series of preliminary experiments upon a large scale were made by the writer nearly a year ago with a locomotive on the Philadelphia & Reading Railroad.

These tests were made with a locomotive selected by the railroad company, a "consolidated engine weighing 111,000 pounds (one of the heaviest and most powerful in the service of the road), of which 98,000 pounds, or nearly 50 tons, were distributed over *eight* coupled driving wheels, measuring about 54 inches in diameter. The traction current was generated by a special low-tension, direct-connected steam-driving dynamo mounted upon the locomotive, one terminal being connected by a heavy stranded copper cable with the forward and rear pairs of drivers respectively, which were insulated from the frame of the locomotive by special insulated brasses at the boxes and journals, the opposite terminal of

* THE ELECTRICAL WORLD, Aug. 27, 1887.

*It appears that the presence of water or oil upon the rails, as shown by these experiments, has a tendency to confine the passing current to a much narrower and smaller area of contact between the wheels and rails, thereby enabling a given current to produce a much greater heating effect at the very point where it is wanted. In other words, the weight upon the drivers is sufficient to "squeeze out" whatever oil may lie directly under the mathematical line of contact; but the film of oil or water at either side of this line offers sufficient resistance to the low tension current to confine the passage of the traction current to the exceedingly narrow portion of the wheel surface in actual metallic contact with the rail. Thus, what has always been a decided disadvantage to mechanical traction is, or may be, utilized in a most important manner in increasing traction electrically.

the dynamo being connected with the two intermediate pairs of drivers. This arrangement was adopted to avoid interruptions in the circuit at the rail joints, which on this road, as is usually the case elsewhere, were not directly opposite on both rails, but overlapped. The average resistance of the traction circuit with the locomotive at rest measured less than one two-hundredth of an ohm, practically all of which was located at the respective points of contact between the wheels and rails. The current could be varied during the different tests by varying the field strength or speed of the dynamo, or both, from about 500 ampères to the maximum output of the machine.

The first experiment was made on a substantially level track, and consisted in coupling the locomotive to a train of 12 loaded coal cars and setting the brakes on these so that the engine could not possibly start the train without continuous slipping, several unsuccessful attempts to do so being made. The dynamo was then started up and the trial repeated with *entire success*, the train being brought under full headway from a position of rest without a single slip of the wheels. This was repeated a number of times, the engineer being instructed to do his utmost to make the wheels slip while the current was flowing, as by suddenly throwing open the throttle to its widest extent with the eccentric lever in its foremost notch, etc., without effect. It was estimated that the load moved by the engine during this test was equivalent to a train of 110 cars!

A number of subsequent tests were made on the Frackville branch of the Reading Railroad, upon a steep mountain grade seven miles in length, averaging 185 feet to the mile, and with numerous sharp and difficult curves. Regular service runs were made over this grade both with and without the current, under conditions as nearly alike as the traffic over the road would permit, with entirely satisfactory results. The official records of the tests show that in nearly every instance the use of the current produced a decided increase in the tractive capacity of the locomotive, and prevented the enormous wear and tear, loss of time and consumption of coal occasioned by the excessive slipping that took place when natural adhesion alone was relied upon. On one occasion the time required to ascend the grade with a load slightly in excess of that usually carried was, without current, 55 minutes, as against 29 minutes with the current flowing, under exactly similar conditions. The amount of coal consumed on the last-named trip was *less than one-half* of that used on the trip without current, by reason of the absence of the rapid exhaust and loss of power consequent upon the slipping of the drivers.

These tests, though made under some disadvantages, were so satisfactory that they are now being continued under conditions and auspices more favorable for carrying out this work. It is estimated that the tractive adhesion of steam locomotives can by this method be increased 25 per cent., and even more in special cases, or where the construction of the locomotive is such as to permit it to utilize a greater increase. This not only means that four locomotives will be enabled to do the work that now requires five, but that longer and heavier trains can be moved, better time made, steeper grades operated, quicker stops effected, inertia more promptly overcome and more fuel saved than by the present methods, and what is perhaps of the greatest importance, without any material increase in the weight upon the drivers or roadbed. These and other advantages are by no means limited to steam locomotion, but apply to electric railway operation with equal or even greater force.

The question will now be probably asked: "Are the conditions existing on electric railways employing the rails as a return conductor for the propelling current such as render this current a factor in increasing the traction, and, if so, to what extent?" Before answering this question let us briefly review these conditions.

In the early days of electric railways the potential difference under which the motors were operated was very small, in some cases as low as 120 volts, and the currents correspondingly large. The track rails were usually of some obsolete light-weight T pattern that had done more or less service on some suburban horse railway line, and the bearing surface of which was curved to such an extent that the driving-wheel contact amounted barely to a point. Under these circumstances a useful amount of increased traction was obtainable, especially in starting the motor on a grade, when the flow of current was unusually heavy. On "single trolley" railways, as at present operated, under a potential difference of 500 volts, the currents employed are not sufficiently large to produce increased traction by the *direct heating* of the metals in contact, except when, as sometimes happens, the tread of the wheel runs upon an exceedingly narrow portion of the rail surface, and even this effect is largely if not entirely counteracted by the high E. M. F. of the current.

However, a certain amount of increased traction may be, and often is, *indirectly* produced by the current on single trolley railways. This occurs when the contact between the wheels and rails is temporarily interrupted at more or less frequent intervals by particles of sand or other foreign matter on the rails, thereby giving rise to small electric arcs and producing the "flashing" noticed under these conditions. The heat generated by these arcs is, in many cases, sufficient to soften the metal and to cause an actual fusing or welding action between the surfaces of the wheels and rails when they again meet beyond the grain of sand or other obstruction, the latter being sometimes vitrified or decomposed by the arc, or imbedded in the heated metal. As the car moves forward, the arc, which is originally sprung behind the obstruction, advances along the wheel and rail to a point in front of it, and the points of the metal thus heated, approaching each other, unite under pressure and almost instantly cool, extinguishing the arc in so doing and producing a more or less perfect weld at the point of contact, to which the increased traction is due. The welds thus formed are again broken, during the separation of the wheel and rail surfaces, on their line of least resistance, which is generally that corresponding to the original surfaces because of the film of oxide and other impurities usually found between the fused metals, and which in most instances prevents a homogeneous weld.

From this it will be seen that notwithstanding the small volume of the current on single trolley railways an appreciable amount of increased traction may manifest itself by reason of the comparatively high electromotive force, producing a change in the action of the current. The use, for example, of a moderate amount of sand in conjunction with the current on grades of more than usual steepness will serve to increase the adhesion both mechanically and electrically to a certain extent, but this plan is not nearly as efficient, economical or reliable, leaving out for the present the question of its advisibility, as the employment of a current of lower voltage and larger volume for the direct and uniform heating of the contact surfaces.

It may be stated in conclusion that, while it is possible to obtain a certain appreciable percentage of increased traction on electric railways in which the propelling current is returned through the wheels and track rails, and while in some few cases a slight increase is necessarily present as a function of the propelling current, yet the conditions under which such roads are usually operated are not favorable to the production of such increased traction. Numerous experiments made by the writer have shown that the most satisfactory and economical method of employing the electric current as a traction-increaser, whether on steam or electric railways, is to establish an independent low-resistance circuit, including the driving wheels and so much of the track rails as lie between them, and to charge this circuit with a low-tension traction current capable of producing the desired heating effect. As this circuit is entirely independent of, even though it may be derived from, the motive power of the vehicle, the amount of increased traction can be regulated without regard to the speed of the motor, and can also be used on down grades to assist the brakes in stopping the car. The increase in the adhesion on single trolley roads under the most favorable conditions is limited by the low heating effect of the propelling current, whereas in the case of the independent traction circuit there is practically *no* limit to the amount of increased adhesion obtainable, since this adhesion may be increased to such an extent as to actually weld or "freeze" the driving wheels to the rails.

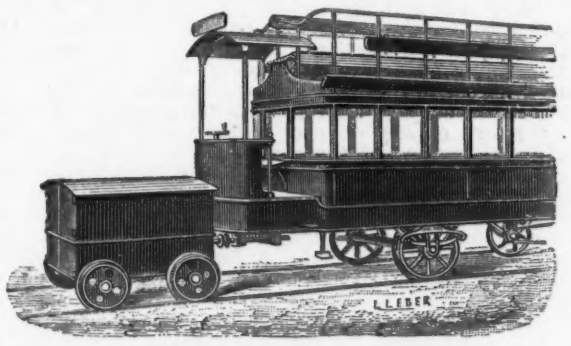
The Comparative Cost of Storage Batteries and Horses in Street-Car Traction.

BY PAUL GADOT.

III. MOTOR CAR, WITH ACCUMULATOR TENDER.*

This third solution of storage battery traction consists mainly in placing the motor and mechanism upon the car itself, which has the driving wheels also, but in using a small tender for carrying the accumulators. This tender, of course, may be hitched on or off the car with as much ease as a pair of horses, thus greatly facilitating the changes of batteries, since each tender contains a complete group of accumulators, and these are never removed from it, except for repairs, etc.; the group is handled, charged, etc., without being disturbed in its position in the tender.

It is not essential that the tender run on its own wheels during the journey; it might be carried by the passenger car, though this would increase the weight on at least one of the axles. The important point is that this car tender can run on its own wheels, with its complete group of batteries, from the station to the track and *vice-versa*, so



Gadot Storage Battery Tender.

that the passenger car need not leave the main track, and need never be delayed by change of batteries, except only for the time needed to couple the tender.

In this system, also, the question of adhesive force need not be considered. As in the motor car, the driving wheels will always be sufficiently weighted to furnish all the friction required.

As in the previous cases we examine the cost of traction for the various numbers of groups of batteries per car per day; one group for 100 kilometres, two groups for 50 each, three groups for 33⅓, four for 25, etc. The car drawn is, of course, the same as before, the one used in Paris for 50 persons, and the figures and coefficients adopted in the preliminary notes page 321, are still valid for our use:

	Kilograms.
The car, we said, weighs, complete	7,000
The weight of motor, mechanism, etc., may be put at	400
Total	7,400

The weight of the tender alone will vary with the weight of batteries it carries; but we may assume that it will weigh one-fourth as much as its burden.

Our equation *H* (page 321) therefore becomes

$$(P + z + x)\, L \times 0.005 = x;$$

z being the weight of the tender $= .25\,x$; P the weight of the passenger car complete; 0.005 the weight of accumulators necessary per kilogram kilometer, ascertained previously (page 321); and x the weight of the batteries needed.

Hence

$$(P + .25\,x + x)\, L \times 0.005 = x; \text{ or}$$
$$(P + 1.25\,x)\, L \times 0.005 = x. \qquad (K)$$

Replacing P and L in (K) by their numerical values in the case of one, two, three, etc., groups of batteries per car per day, we have:

1. *With one group, for* 100 *kilometers:*

$$(7{,}400 + 1.25\,x)\, 100 \times 0.005 = x;$$

whence, $x = 9{,}867$ kilograms, weight of the group of accumulators. This weight is evidently once more prohibitive.

2. *With two groups, each for* 50 *kilometers:*

$$(7{,}400 + 1.25\,x)\, 50 \times 0.005 = x;$$

whence, $x = 2{,}691$ kilograms, weight of each of two groups. The tender will weigh $2{,}691 \times .25 = 673$ kilograms.

3. *With three groups, each for* 33⅓ *kilometers:*

$$(7{,}400 + 1.25\,x)\, 33.333 \times 0.005 = x;$$

whence, $x = 1{,}558$ kilograms, weight of each of three groups. The tender will weigh $1{,}558 \times .25 = 390$ kilograms.

In the same manner, with four groups $x = 1{,}096$ kilograms; with five, $x = 846$ kilograms; the weight of tenders being, respectively, 274 and 212 kilograms.

Remembering (*F*, page 321) that for every 5 kilograms gross of accumulators there are 3.5 kilograms net weight of plates, we form the following table:

No. of Groups.	Distance per group.	Wt. of batteries per group	Wt. of plates per group.
1 Group	100	9,867	6,907
2 "	50	2,691	1,884
3 "	33.333	1,558	1,091
4 "	25	1,096	767
5 "	20	846	592

Each change of batteries is here very simple; the car remains on the tracks, and the tender, drawn to the station, is replaced by another in readiness. The process is precisely that now used in changing horses.

The weight of the tender and its group of batteries will be:

With 2 groups per car per day... = 2,691 + 673 = 3,364 kilograms.
" 3 " " " ... = 1,558 + 390 = 1,948 "
" 4 " " " ... = 1,096 + 274 = 1,370 "
" 5 " " " ... = 846 + 212 = 1,058 "

For drawing the tenders to and from the station a man and a horse will be needed, though the man alone might suffice in the case of four or five groups. The horse will cost 1,200 francs, and his care, food, replacement, etc., plus interest, insurance, etc., may be 5 francs per day; say 1,800 francs per annum.

We can now begin our detailed examination of the cost per car kilometer under each case.

First. *With one group.*—We have seen that the enormous weight of the accumulators renders this hypothesis impracticable.

Second. *With two groups, each driving the car* 50 *kilometers.*—

Number of cars for service, 20; in reserve, 5; total, 25.

Number of tenders or groups: Two for each car in service = 40. Reserve, 15 per cent. Total, 46.

Weight of batteries: Each group weighs 2,691 kilograms. For each car, $2{,}691 \times 2 = 5{,}382$.

For the 20 cars in service, $5{,}382 \times 20 = 107{,}640$ kilo.
Fifteen per cent. in reserve..... 16,146

Total weight of batteries..... 123,786

Corresponding to a net weight of plates of 86,664 kilograms.

Charging the batteries.—From (F) we find that each kilogram of the plates requires, in charging, a force of 11,425 kilogrammeters; therefore for 75,360 kilograms of plates there will be needed per day $11{,}425 \times 75{,}360 = 860{,}988{,}000$ kilogrammeters. Say 3,189 h. p. hours, or about 210 h. p. during 15 hours.

These last figures will enable us to ascertain the cost per kilometer of running each car. This cost will include:

a. Salaries in the station, less those stated elsewhere under cost of motive power.

In the case of the motor car we had 115,000 kilog of batteries, against 123,786 now; but the process of handling is now incomparably simpler and quicker. By this means we economize to the extent of three laborers and one electrician (8,100 francs); but we have to have a horse at 1,800 francs per annum, so that the net economy is 6,300 francs. Our figures for the automobile car were 42,600 francs. Deducting 6,300 from this leaves 36,300 francs, as the cost of salaries in station

b. Twenty-one car drivers, of which one is for emergencies, 63,000 francs.

c. Motive power.—There are 3,189 horse-power hours per day, which we shall estimate at 0.085 franc each, this liberally covering interest, wear and tear to motors and boilers, salaries and all repairs, maintenance, oil, etc. Per day, $3{,}189 \times 0.085 = 271.06$ francs; per annum, $271.06 \times 365 = 98{,}936.90$ francs.

d. Interest on battery capital.—We have 86,664 kilograms of plates, at a cost, including construction, boxes, insulators, acids, etc., etc., of 1.25 francs per kilogram, $86{,}664 \times 1.25 = 108{,}330$ francs; interest at 6 per cent. = 6,499.80 francs.

e. Repairs to accumulators, boxes, insulators, acids, etc., and change of plates may be put at .25 franc per annum per kilogram of plates, instead of the previous .30, because the changes are now made without shaking and with much less chance of injury. Whence $86{,}664 \times .25 = 21{,}666$ francs.

f. Loss of plates.—The plates alone cost 0.85 franc per kilogram $= 75{,}360 \times 0.85 = 64{,}056$ francs. They must be renewed, considering the very hard usuage they undergo, say twice a year. There will be thus an expense of

$64{,}056 \times 2 = 128{,}112$ francs.

From which must be deducted the price of the old plates, say at 0.20 francs per kilogram: $75{,}360 \times 2 \times 0.20 =$ 30,144 "

Leaving an annual expense of ..... 97,968 "

g. Interest on capital; motors, machinery in cars, etc.—For purchasing dynamo and machinery, etc., may be allowed 2.600 francs; or $25 \times 2{,}600 = 65{,}000$; at 6 per cent. = 3,900 francs.

h. Repairs to same.—At 450 francs per car may be estimated at 11,250 francs per annum.

i. Deterioration of same may be taken at 20 per cent., owing to the special conditions under which they are placed. We have then 65,000 francs (see *g*) $\times 0.20 = 13{,}000$ francs.

j. Here should be added interest, deterioration and repairs to tenders.—Each tender costs about 540 francs. There are 46 of them: $540 \times 46 = 24{,}840$ francs. Allowing 20 per cent. for all charges, this item comes annually to 4,968 francs.

k. Oil, waste, small details, etc., on dynamos, tenders and cars, may be placed at 2.75 francs per day per car in service.

$2.75 \times 20 \times 365 = 20{,}075$ francs.

l. Maintenance and repairs of tools may be placed at 6,000 francs per annum.

m. Interest, deterioration and repairs of the charging dynamos, transmitters, belts, etc.—Taking the capital at 33,600 francs, and allowing 25 per cent. to cover all, we have an annual charge of 8,400 francs.

n. Various charges, 10,000 francs.

The Frankfort Exposition.

A report comes from Frankfort-on-the-Main that extensive preparations are being made for the electrical exposition to be held there next year. In particular, the well-known Oerlikon Company has made arrangements to construct a large electrical boat, operated by accumulators and large enough to accommodate 100 passengers. This boat is intended to run on the Main between the inner city and the eastern portion, where the exhibition is located,

*Gadot system.

Special Correspondence.

NEW YORK NOTES.

OFFICE OF THE ELECTRICAL WORLD,
167-177 TIMES BUILDING, NEW YORK. May 31, 1890.

The Julien Electric Company are doing a good business at their factory, with a large number of orders on hand. They say that within ten days they will have ten cars in operation on the Fourth avenue railroad.

The Fred. H. Whipple Company, whose New York offices were formerly at 18 Cortlandt street, have removed to 622 Temple Court Building, on Beekman street. The company, as no doubt most of our readers are already aware, are the proprietors of Whipple's general and confidential reports to the electrical trade.

The American Institute of Electrical Engineers have removed their headquarters from 5 Beekman street, this city, to the house of the American Society of Mechanical Engineers, at 12 West 23d street. This building has lately been acquired by the Mechanical Engineers, who have had it handsomely fitted up for offices, reading room, auditorium, library, etc. All communications for the Electrical Engineers should be addressed to their new location.

Messrs. Edwards & Co., New York, have brought out a new system of gas lighting for halls, theatres, and the like, which possesses some novel features. They attach a small condenser to each burner, and light the burners in multiple instead of in series, by the use of the Rhumkoff coil actuated by any simple battery. This system can be attached to any ordinary burner and does not require the elaborate insulation preparations of methods ordinarily in use. It is said to work admirably for the purpose intended.

Mr. Pratt Stratton, well known in electrical circles as an expert on machinery and mechanics, was met by your correspondent one evening last week on the steamer "Massachusetts," of the Old Colony Line. In conversation Mr. Stratton expressed very freely his views on electric marine lighting, and they were of the most practical and realizable description. This gentleman is the inventor of the Stratton separator, and other valuable steam-saving apparatus, and is marine engineer and inspector of vessels for the Marine Underwriters in New York City, in which latter capacity he has just inspected a large steamship at Boston.

James H. Mason is now bringing out a neat little fan outfit for the summer trade. It consists of a small motor with fan on the armature spindle, operated by the Mason primary battery. The price is low, and, as the power required is small, the expense of running is slight compared with the comfort that can be derived from a device of this sort. Mr. Mason reports increasing demand for his batteries for fan and sewing machine motors and the operating of small lamps. The new fan should prove useful in places where electric light currents are not readily available; as in country houses, out of the way rooms, and the like. It is small and light enough to be readily moved about from room to room, if necessary.

W. T. H.

NEW ENGLAND NOTES.

BRANCH OFFICE OF THE ELECTRICAL WORLD,
No. 146 Franklin, corner Congress St.
BOSTON, May 24, 1890.

Mr. Porter, of the Porter Teletype Company, of New York, was in town last week.

The Consolidated Electric Company of Boston have just issued a new catalogue of lamp supplies, electrical specialties, etc., which any one using the American system of arc lighting will find of much service in the ordering of duplicate parts.

The Hadley Company, the first spinners of fine cotton yarns in this country, whose mills are at Holyoke and who have an agent at 95 Milk street, Boston, are furnishing a large number of principal wire companies with their goods. Their yarns are spoken of very highly by consumers.

R. P. Smith, Northeastern agent of the Connecticut Water Company, reports the sale of two 10-h. p., one 7½-h. p., one 5-h. p and one 3-h. p. within a few days. Mr. Smith is a gentleman who thoroughly understands his business, and the results of his efforts as shown by these orders, are in a high degree satisfactory.

Thomsom-Houston Debenture Bonds.—A debenture bond company has been organized, under the laws of Maine, to purchase the bonds of the Thomson-Houston company and issue against them debenture bonds. The first issue of debentures will be $1,000,000, and already more than that amount has been applied for. By this means the Thomson-Houston company secures a large amount of ready money for conducting its business, which has grown beyond its financial capacity. The gross amount of capital in use is now about $1,000,000 per month.

The Mason Regulator Company, Boston, Mass., are presenting to those who will send a stamp to cover postage, a neat little book for holding postage stamps. The leaves of the book are specially prepared, and stamps may be placed between them and the book carried in the pocket without danger of the stamps sticking together. The business done by this company in May was three times as great as that done in the same month last year. Last week they received an order from the Rock Island Railroad for 36 pressure regulators, and another from the Pennsylvania Railroad for 12.

New Trolleys for the West End Road.—Twelve new detachable trolleys combined with the steel trolley car will be sent to the West End Road from the Thomson-Houston factory this week. This car is in sections, the upper section being a steel rod, which is quite flexible and not liable to slip from the trolley wire in going around curves or when the wire varies from the centre of the track. A new Wightman controller, which has been used experimentally on the Lynn and Boston line, will be sent up to the West End road this week; it takes the place of the rheostat and requires much less current than the present device.

New Electric Buildings at West Lynn, Mass.—The Thomson-Houston Electric Company of Lynn, Mass., have purchased 7,000 feet of land adjoining factory I, on Berkley street, of James McDermott, on private terms. This gives them a chance to run their spur track from factory H, which has been partially built for some time, but which has been waiting for John Welch to sell a piece of land which the company desired to cross. The track connects with the Saugus branch, near the Lynn Common depot. The plans for two new buildings for the Thomson-Houston group were last week submitted by Architect E. P. Ball, of Palmer, Mass. The great extension to Factory C, to be used for the heaviest work done by the company, will be 79 feet wide by 189 feet 4 inches long, three stories in height. It will entirely cover the width of three lots recently purchased on Federal street. The new testing house for large generators will be in the rear of the Factory C extension, and will be 50 wide by 159 feet 10 inches long. A spur track will run from the B. & M. tracks through the yard of Factory H and the Factory C extension into the testing house, so that the dynamos after being tested may be lifted on to the cars by traveling cranes and then shipped to their destination. The extension to Factory I of the Thomson-Houston Electric works is nearly ready for occupancy.

The Electric System in Boston.—President Whitney, of the West End Railway, in his speech before the Roxbury Club on May 24, said: "The electric system has proven in practice all I have ever claimed for it in my speeches before this club, and I think it is generally admitted that the system is vastly better than anything else that you have had. With the improvements that are sure to come, I feel that we shall soon have a system of street transportation service that will be in every way satisfactory to the people. The objectionable features will disappear so far as it is possible to eliminate them by mechanical devices; larger and quieter cars will come, and more frequent service will be given." The speaker stated that the transportation service was increasing at the rate of from 30,000 to 40,000 per day year by year, and their idea in asking for a franchise for an elevated structure was to cover the crowded portion of the city where Washington and Tremont streets come near together, and where a surface railroad doing its work well was almost impossible. It is possible to give good transportation facilities on both sides of this crowded portion, and the speaker thought the public would be more satisfactorily treated if an elevated structure covering these points was built. He stated that 350,000 passengers were carried daily by the West End system, and if they (the West End Railway) were given proper encouragement, the solution of rapid transit for Boston would be quickly reached.

L. H. H.

WESTERN NOTES.

BRANCH OFFICE OF THE ELECTRICAL WORLD,
465 The Rookery, Chicago, May 24, 1890.

A Large Order.—The Central Electric Light Company, of Chicago, Ill., has recently taken an order for 1,000,000 feet of Okonite wire. They have also sold an entire equipment of Candee wire for an electric railway system.

The Western Electric Company, of Chicago, Ill., has been sued in the United States Circuit Court by Mr. Horace E. Waller, of Utica, N. Y. Mr. Waller seeks to enjoin the company from selling or disposing of an electric burglar alarm, and also a hotel annunciator.

Milwaukee, Wis.—Work has been begun on the power house of the Edison Electric Light Company. The building will have a frontage of 100 feet on River street, and a depth of 115 feet. It will be two stories, and brick and iron will be used in the construction.

Mr. George Cutter, of Chicago, has, with some other capitalists, formed the Great Western Electrical Supply Company, with offices located at 190 and 192 Fifth avenue, Chicago. Mr. Cutter has transferred his business to the new company, and will give his personal services in the conducting of the company's affairs. A large stock of electrical supply goods will be kept in Chicago, and stores will also be maintained in St. Louis, Kansas City, Denver, Portland, Minneapolis and St. Paul. All business communications for Mr. Cutter should be addressed to the above company at Chicago.

Telephone Quotations.—Col. S. G. Lynch, broker, 153 Monroe street, Chicago, furnishes quotations on telephone stocks as follows:

Chicago	$295@$300	Cumberland	$ 59@ $60
Central Union	70@ 71	Wisconsin	116@ 117
Michigan	98@ 99	Bell of Missouri	140@ 145
Great Southern	30@ 32	Iowa Union	21@ 2.
Colorado	38@ 40	Missouri and Kansas	54@ 55
Rocky Mountain Bell	40@ 45		

ELECTRIC LIGHT STOCKS.

Chicago Arc Light and Power	$115@$118	Chicago Edison Co	$121@$130

F. DE L.

ENGLISH NOTES.

(From our own correspondent.)

LONDON, May 21, 1890.

Electric Lighting Legislation.—At the last meeting of the Institution of Electrical Engineers, Major Carden, R. E., electrical advisor to the Board of Trade, read a long paper dealing with the legal questions connected with electric lighting, in which he claimed that the Board of Trade is animated by a desire to make things as pleasant for those engaged in distributing electricity as is compatible with public safety. In the discussion that followed, the speakers were generally of opinion that electric lighting enterprise in this country had suffered considerably from over legislation, and that progress would have been more rapid, without a proportional increase of danger to the public, had the distribution of electricity been left more to the electric companies. Mr. Crompton, Mr. Schoolbred, Mr. George Offer and others, pointed out how detrimental were the cost and time which it now took to obtain a provisional order; and the last gentleman sensibly suggested that the confirmation by Parliament of provisional orders granted by the Board of Trade was, to the lay mind, an unnecessary procedure.

Proposed Government Standardizing Laboratory.—At the last meeting of the Institution of Electrical Engineers, Major Carden announced that the government standardizing laboratory, which has for so long been on *tapis*, is at last in a fair way to become a reality. It is proposed to start on a very modest scale as regards equipment, but Major Carden is of opinion that the laboratory will soon grow in size and importance. The first work to be accomplished at this laboratory will be the re-determination of the fundamental electrical units; and it is to be hoped that, with the assistance of Lord Rayleigh and others, the government determination will surpass in accuracy any hitherto made. It is proposed to have two batteries of accumulators, one of which will be able to give a large discharge (up to 2,000 ampères). There will also be four dynamos, two of which will be run off the accumulators as motors and drive the other two as generators. It is expected that work will be commenced within the next month or so.

The Board of Trade and the Electric Light.—I referred in my letter of April 23 to the fact that the Board of Trade had proposed, in granting powers to the Eastbourne Electric Light Company, to insert in its provisional order a clause fixing the maximum price to be charged for 1,000 watt hours at 8d., as against 10d., which the company asserted was its irreducible minimum. I am glad to be able to say that the vigorous representations of the Eastbourne Company that 8d. per unit meant a dead loss, have resulted in the Board of Trade leaving the maximum price at the figure originally proposed.

Technical Education.—In a paper recently read before the Society of Arts on the "Aim and Scope of Higher Technical Education," Professor P. F. Frankland urged our universities of Oxford and Cambridge to develop their teaching in the direction of higher technical education. The size, organization, methods of instruction and architectural splendor of the technical universities of Germany seem to have deeply impressed Professor Frankland; but whatever may be said for the training of embryo engineers for a few years in technical schools in order that they may gain a thorough insight into the scientific side of their profession, the advantages of imitating Germany in its lavish expenditure on higher technical education may well be doubted. A large percentage of those who are turned out of the institutions which excite Professor Frankland's unbounded admiration, fail to turn their instruction to any practical purpose.

The Lane-Fox Distribution Patent.—The name of Mr. St. John Lane-Fox is doubtless as well known on your side of the water as it is on ours. This gentleman not only ran a close race with Edison and others in the matter of incandescent lamp patents, but was one of the first, if not the very first who had a clear idea as to the best way to distribute current on a commercial scale. In his patent, No. 3,988 of 1878, Mr. Lane-Fox described a system of constant potential distribution combined with accumulators, which were to serve as "reservoirs of electricity." This patent has been held up to the last few months by the Brush Electrical Engineering Company, but at the beginning of the year a company was formed for the purpose of exploiting this and other patents belonging to Mr. Lane-Fox. The Lane-Fox Electrical Company now announce their intention of claiming royalties from persons whose operations they consider to come within the scope of the patent No. 3,988 of 1878. While there can be little doubt as to the originality of Mr. Lane-Fox's idea, this system of springing patents which have long lain dormant, upon the electrical industry, is not one that commends itself as being particularly straightforward.

THE TELEGRAPH.

Sterling, Ill.—Chief Ives recommends the purchase of an electric fire alarm system.

Fisher's Island, off the east end of Long Island, is soon to be connected with New London by telegraph cable.

St. Paul and Minneapolis are to have their fire alarm systems connected. The expense will be shared by the twin cities.

Williamsport, Pa.—A good electric fire alarm system is evidently needed at this place. The present mode of sending in alarms by telephone was shown during a recent storm to be lamentably untrustworthy.

The Halifax and Bermuda Cable is now en route to its destination in the steamer "Westmeath." It is 874 miles in length and weighs 3,061 tons. A subsidy of £8 100 has been granted to the company by the British government, but the post office authorities have insisted on certain conditions as to the capacity of the cable all of which requirements have been fulfilled. It is expected that communication will be established by June 24. The tariff will be three shillings per word between Halifax and the Bermudas, and four shillings from England.

THE TELEPHONE.

Rochester and Great Falls, N. H.—The telephone line between these places has been rebuilt.

The Gamewell Fire Alarm Telegraph Company announced that their agency has been transferred from the California Electrical Works, San Francisco, to Frank C. Stoner.

Friend, Neb.—The central telephone station was partially burned out last week. The fire was caused by lightning, which jumped the arresters and kindled the blaze from the switchboard. The loss is $1,000.

Mr. W. J. Burden, Manager of the New England Telephone Company in Burlington, Vt., has gone to St. Albans to superintend the construction of a telephone line from St. Albans Bay to Samson's Lake View House, and a station to connect at the Point House.

The International Bell Telephone Company reports having total assets and liabilities of $2,314,023 Dec. 31, 1889, and a profit balance of $270,693. The leading assets were: Russian construction, patents, etc., $1,297,778; ditto in other European countries, $501,055; shares in sub-companies, $108,688; supplies, $48,224. The leading liabilities were: outstanding capital, $1,309,500; bonds, $192,600; reserve funds, $376,489; sinking fund, $66,172.

The Oregon Telephone and Telegraph Company has been incorporated at Pendleton, Ore., by W. B. King, J. R. Thatcher and John Lawrence. The articles state that it is the incorporators intention to buy and dispose of real estate, erect buildings, start electric plants, and do a general telegraph, telephone and messenger business in the several states and territories of the United States. The capital stock of the enterprise is placed at $500,000, divided into 5,000 shares, each share having a value of $100.

A Roland for an Oliver.—The counsel for the Southern Massachusetts Telephone Company has served papers on the president of the New Bedford, Mass., Street Railway Company, notifying him that the telephone company will hold the street railway company liable for any damage which results to the telephone system through operating the road by electricity. The railroad company has retaliated by serving notice on the telephone company that it would be liable for any damage which might result from telephone wires falling upon the electric railway wires.

Putting Telephone Wires Under Ground.—It is stated that during the present year the telephone wires of Atlanta, Ga., are to be placed under ground. This step has been under consideration for some time by the Telephone Company, and it is now thought to be certain that early action will be taken. This is to be a part of the extensive improvements contemplated for the Atlanta Exchange. District Superintendent Cole, of the Telephone Company, says that $250,000 will be spent by the company in improvements. The Telephone Company will make application to the City Council for permission to lay the wires under ground. It will take two years to complete the work.

THE ELECTRIC LIGHT.

Elkhorn, W. Va.—An electric light plant will probably be erected.

Atlantic, Ia.—It is proposed to establish an electric light plant at this place.

Moubo, N. C.—An electric light plant is to be added to the Moubo cotton mill.

Fairbury, Ill.—The electric light company will probably have to enlarge its plant.

Sonora, Cal.—Otto Kaing has been granted a franchise to erect an electric light plant.

Jamestown, R. I.—The people of this place are agitating the question of electric lights.

Navasota, Tex., will put in an incandescent electric plant in connection with water-works.

The Hastings, Neb., Electric Light Company will probably put in another dynamo.

Mt. Holly, N. C.—An electric light plant is to be added to the equipment of the Mt. Holly Mills.

Mansfield, O.—Improvements will be made to the plant of the Mansfield Electric Light and Power Company.

Goldsboro, N. C.—The Eastern Carolina Insane Asylum near this place, has put in an isolated electric light plant.

Baltimore, Md.—The capital stock of the Brush Electric Light Company will be increased from $500,000 to $1,250,000.

Birmingham, Ala.—An electric light plant is to be put up at the furnace of the Vanderbilt Steel and Iron Company.

Whitesburg, Ga.—An isolated electric light plant is to be added to the paper-mill of the Wilkinson Paper Company.

Bristol, Conn.—The Bristol Electric Light Company will add new boilers to its plant, besides making other improvements.

Riverton, Ala.—The contract for constructing an electric light plant has been awarded to Geo. W. Swartz, of Florence, Ala.

The Standard Electric Company, of Vermont, has put in over 40 plants during the past year, aggregating 10,450 lamps.

Oxford, Ala.—It is said that the city has contracted for the erection of an electric light plant. The mayor can give information.

The Hot Springs, Ark., Electric Light Company will, it is reported, put in a plant with a capacity for about 1,500 incandescent lights.

Flemingsburg, Ky.—An electric light plant will be erected by D. J. Hauss, who has been awarded a contract to light the town with ten arc lights.

Dunkirk, N. Y.—A petition has been presented to the officials of this place, asking that a public election be held to decide for or against electric lights.

Sunbury, Pa.—Within the next 30 days the Edison Electric Light Company will have an arc light system started in this town, with a capacity of 65 lights.

Elgin, Ill.—The Elgin Light and Power Company has been incorporated at this place, with a capital stock of $100,000. I. C. Townes can furnish particulars.

Eaton Rapids, Mich.—The electric light plant at this place, it is said, does not give satisfaction. There may be an opening there for another company soon.

Wellsville, O.—The Valley Gas Company has increased its capital stock to $45,000, for the purpose of erecting an electric light plant in addition to its gas plant.

Gainesville, Fla.—The electric light and gas plant of the gas and electric light company has been bought by the Southern Gas Trust and Construction Company.

Wilkensburg, Pa.—Work is being rapidly pushed on the new station of the Wilkensburg Electric Light Company, which is to operate the Thomson-Houston system.

New London, Conn.—The Onco Electric Light Company is extending its system rapidly. The public and private lights now number 82 arc and nearly 600 incandescent.

Wilmerding, Pa.—A 1,500-light plant, to use the Westinghouse alternate current incandescent system, is being constructed with the greatest possible degree of rapidity.

Waxahachie, Texas.—The officers of the newly incorporated electric light company are; O. E. Dunlap, president; T. R. Anderson, vice-president; and R. G. Phillips, secretary.

Mr. J. R. Magee, of the Thomson-Houston Isolated Department, closed a contract with the Penn Mutual Life Company, of Philadelphia, last week, for 2,033 incandescent lamps.

New London, Conn.—The Onico Electric Light Company is extending its system rapidly in this city. The public and private plants now number 82 arc and nearly 600 incandescents.

Goldsboro, N. C.—The electric light plant has been completed, and the current will be turned into the street lamps when the contract with the gas company expires, which will be in a few days.

Santa Cruz, Cal—H. H. Clark has been elected president of the electric light company; J. F. Appleby, vice-president; A. P. Swanton, treasurer; F. W. Swanton, secretary and manager; C. E. Lilly, electrician.

New Haven, Conn.—The street light committee is in conference with the electric light company officials in regard to increasing the number of electric lights, and reducing the candle-power from 2,000 to 1,200.

Asheville, N. C.—The new electric light plant to be erected by L. U. Cox, of Washington, D. C., will consist of 100 arc and 1,000 incandescent lights, and will be one of the largest electric plants in North Carolina.

Halifax, N. S.—The board of works has recommended the city council to give notice to the Halifax Electric Light Company, that its contract for lighting the city would terminate six months from the 24th of May.

The Mather Company, of Manchester, Conn., has orders for lighting two theatres, one at Milwaukee, Wis., and the other at Denver, Colo., with 1,600 lights each. The company is also filling a 1,000-light order for a large building in Chicago.

Burlington, Vt.—The new condensing engine has been set up and is now in running order, at the plant of the Citizens' Light and Power Company. It is of sufficient size to supply the power for all the lights in use, including those in the woolen and merino mills.

Cincinnati, O.—Mr. Chas. Hill, well known in electrical circles in this section of the country, has just completed an installation of 32 arc lamps for lighting the summer resort known as Coney Island, located eight miles above Cincinnati, on the Ohio river.

West Duluth, Minn.—The old electric light company has submitted a proposition to the City Council to enter into a contract with the city to furnish thirty arc lights at the rate of $10 per month each. This is quite a reduction from the former rate.

Greenville, S. C.—The city council at a meeting last week disposed of the question of electric lighting by turning over the Brush Company's plant, together with all of its franchises and liabilities, to Asbury & Son, under a contract to light the city for fifteen years.

Napa, Cal.—The Board of Trustees has directed the city attorney to begin suit for the forfeiture of the franchise of the Napa Electric Light Company. A franchise has been granted to the Thomson-Houston Company, and they will install a plant at once.

New Haven, Conn.—The agitation for the removal of the electric light plant from George and Temple streets has resulted in the purchase, by the New Haven Electric Company, of land on Grand avenue, where the plant, or the greater portion of it, will be transferred.

Rutland, Vt.—There are two electric light companies here, and the demand for light is so great that each of them is increasing its plant. The city has just signed a new contract for lighting at reduced rates. Arc lights of 2,000 c. p. are furnished until midnight for 16½ cents, and a few burn all night for 37 cents each.

Morgantown, N. C.—The town council has pledged itself to vote for the issuing of a sufficient amount of six per cent. bonds of the town to build an electric light plant. Representatives of the Thomson-Houston Electric Company have been on the field for a week, and that company will probably be awarded the contract for the necessary equipment.

Electric Light Can be Manufactured by Any City or Town.—The justices of the supreme judicial court in a decision sent to the Massachusetts legislature May 28, declare that cities and towns have the right constitutionally to manufacture and furnish gas and electric light, both for public and private use, thereby completely overruling the decision of the attorney-general.

Three Rivers, Can.—A meeting of the council was held on Saturday night, May 17, at which the long discussed question of lighting for the city was solved, after a battle between the gas and several electric light companies which has lasted two years. The Royal Electric Company, through Mr. A. J. Corribeau, obtained the contract for $35,000. The city will own and operate the plant.

The Salem Electric Light, Heat and Power Company, of Salem, N. J., after having run for nearly three years a very successful incandescent plant, has just decided to go into the arc lighting business also, in order to meet the great demand which is made for that method of illuminating. The company has just contracted with the Westinghouse Electric Company for one of its new arc machines.

Lakewood, N. Y.—Little, McDonald & Co., of Buffalo, N. Y., have the contract for an electric light plant to be put in the New Kent house at this place. Five hundred incandescent lamps will be used inside, and a number of arc lamps will be placed on the tower of the hotel, on the water tower, and at other vantage points about the premises. It is expected that the plant will be ready for operation this week.

East Chattanooga, Tenn.—The Thomson-Houston Company through a representative, has made a proposition to erect a $100,000 electric light and power plant on the property of the land company. The offer has been accepted and the plant will consist of three dynamos, each of 500 horse power. It is stated that the plant will be prepared to dispense not only light to the city, but power to industries ten miles distant.

A Good Use for an Incandescent Light.—By means of a portable incandescent lamps operated by pocket-storage batteries a New York newspaper has just succeeded in exposing a bogus spiritualist. When the medium impersonating a departed spirit appeared, the electric light held by a reporter was flashed, and the whole *séance* exposed. This incident suggests the possibilities of the storage battery in detective work.

The Calkin Electric Light Company, of St. John, N. B., which was incorporated a short time ago with a capital of $150,000 has consummated negotiations with the Fort Wayne Electric Company for 4,000 incandescent lamps of the Slattery induction system and 240 arc lamps of the Wood system. Four 150 h. p. compound condensing engines will be used to furnish the power. It is said that this will be one of the finest plants in the Dominion. The plant will be installed at once.

The Allegheny County, Pa., Light Company loses no opportunity to introduce in its model central station any innovation of value. One of its latest departures is a photometer room. The company has tested this scheme thoroughly, and finds that its patrons are highly pleased with it. Not only are new lamps subjected to test before going into use, but returned lamps are examined, and if carbons are found to be intact the lamps are put into a condition for further use.

Baker City, Ore.—The trustees have granted to R. W. Purdum and E. L. Giroux, an electric light franchise. This ordinance grants the right of way over and through the streets for wire and poles; requires the work to be commenced in 15 and completed in 90 days; provides that 1,000 incandescent and 35 arc lights shall be furnished at $13 50 per month in the city scrip, each, or $12 cost, and 4, 8, 10, 15 and 32 c. p. incandescents at from 40 cents to $3.50 each per month, according to the number of hours used through the night.

North Adams, Mass.—The new electric light station of the North Adams Gas Company is practically completed, and the setting up of machinery will begin at once. The plant consists of a dynamo and engine room 26 × 54 feet, and boiler house 32 × 20 feet, 30 feet high. The electric light machinery will be three 50-light arc dynamos and one incandescent of 50 light power; the buildings are all arranged so that the plant may be enlarged whenever necessary. The Wright Electrical Engineering Company, of Boston, are doing the work.

Alameda, Cal.—The city clerk has been instructed to forward to Indianapolis, Ind., a bill of sale to be signed by the Jenney Electric Company, by which Alameda will come into possession of the remainder of the electric light plant. When negotiations for the purchase of the plant by the city were first entered into, the plant was divided into fortieths, with a value of $1,000 on each fortieth. The city then purchased 15 fortieths, and subsequently two more. It will now purchase the remaining 23 fortieths, for which it will pay $23,000, and the Jenney Company will take municipal bonds in payment.

Sale of Thomson-Houston Stock.—H. A. Pevear, O. Ames, A. Stone, C. H. Newhall and E. L. Sanborn, trustees under the pooling agreement of April 7 among Thomson-Houston Company stockholders, have issued a circular calling upon signers of that agreement to deposit their stock on or before June 5, with the American Loan & Trust Company. The trustees say: "Negotiations have for some time been in progress for the sale of the whole or a majority of the common capital stock of the company. We can only say at present that the price and terms offered are satisfactory." All holders of stock, whether signers of the pool agreement or not, are given the opportunity to deposit their shares and participate in the sale.

Suffolk, Va.—The Thomson-Houston Electric Company, through its representative, has made the city council a proposition to light the town for three years with 80 incandescent lamps of 25 candle power, at a stipulated price; allowing the town the option in five years after acceptance of the proposition, or in two years after the operation of the plant by the company for three years, to purchase the plant at a price to be fixed by a board of arbitration; said board to consist of three members. It was decided to accept the proposition on the conditions mentioned in an ordinance to be framed by the light committee, the provisions of which shall be accepted by the electric light company.

A New Switch Board.—The Allegheny County Light Company, of Pittsburg, Pa., has a new switch board which is very compact, and the working of which is entirely satisfactory. There are two separate parts to the board, a lower front part, of small size, and a larger one arranged behind, covering an entire wall. On the lower portion of the board are the regulators for eight 3,000 light Westinghouse alternate current dynamos. Behind and above are the circuit regulators for 20 circuit of 2,000 lights each. From this switch board are also run three 2,000-light machines in the Allegheny branch of the station. Thus it will be seen that by the one board a dynamo capacity of 33,000 lights is regulated.

Taunton, Mass.—The Taunton Electric Light Company has voted to increase its capital stock from $30,000 to $50,000, and additional land has been bought on which a new two story building, 50 × 50 feet, will be erected. The old building, partially burned by fire, has been rebuilt, and the whole plant is now 100 × 50 feet. The new building will contain a compound engine of 200 h. p. and one of 90 h. p. The Taunton Locomotive Company will furnish a 200-h. p. boiler. When in running order the plant will be three or four times the capacity of the old one. The alternating system of incandescent lighting will be adopted, and the necessary apparatus has been ordered. A power circuit is to be started for manufacturers.

A Good Showing.—The Westinghouse alternating current incandescent system has now been established in nearly three hundred central station plants throughout the country with a total capacity of almost six hundred thousand 16-c. p. lamps. Of these stations the following have a capacity exceeding 1,000 lamps. Albany, N. Y., 1,300; Allegheny, Pa., 13,000; Allentown, Pa., 1,500; Amherst, Mass., 1,500; Annapolis, Md., 1,250, Aspen, Col., $1.400; Auburn, Me., 2,250; Austin, Tex., 5.205; Baltimore, Md., 5,000; Batavia, N. Y., 1,250; Bath, Me., 1,400; Bay City, Mich.; 1,500; Beaver Dam, Wis., 1,300; Binghamton, N. Y., 3,000; Birmingham, Ala., 1,000; Boston, Mass., 3,750; Bristol, Pa., 1,000; Buffalo, N. Y., 3,250; Butte, Mont., 2,250; Carbondale, Pa., 2,950; Cedar Rapids, Ia., 2,050; Chattanooga, Tenn., 1,960; Clinton, Ill., 1,400; Colorado Springs, Colo., 3,450; Columbus, O., 2 600; Conshohocken, Pa., 1,300; Connellsville, Pa., 1,500; Cornwall, Ont., 1,300; Council Bluffs, Ia., 1,250; Dansville, N. Y., 1,000; Denison, Tex., 1,500; Dennison, O. (?), 1,000; Denver, Colo., 16,800; Des Moines, Ia., 1,000; Du Bois, Pa., 10?; Duluth, Minn., 2,800; Eau Claire, Wis., 1,300; Elmira, N. Y., 1,500; Englewood, Ill., 2,200; Flint, Mich., 1,150; Evansville, Ind., 1,300; Fort Worth, Tex., 2,800; Galveston, Tex., 1,300; Greensburg, Pa., 1,350; Hagerstown, Md., 1,300; Halifax, N. S., 1,100; Hamilton, Ont., 2,000; Hartford, Ct., 4,750; Helena, Mont., 1,500; Hoboken, N. J., 1,300; Kansas City, Mo., 3,000; Kansas City, Kan., 1,500; Lincoln, Neb., 1,950; Little Rock, Ark., 2,250; Louisville, Ky., 7,000; Mansfield, O., 1,400; Mauch Chunk, Pa., 1,500; Media, Pa., 1,500; Minneapolis, Minn., 4,500; Moline, Ill., 1,500; Montgomery, Ala., 1,300; Morristown, N. J., 1,300; Nashville, Tenn., 5,500; Newark, N. J., 2,250; New Bedford, Mass., 5,600; Newburgh, N. Y., 1,500; New London, Ct., 1,400; New Orleans, La., 6,500; New York, N. Y., 53.500; Oakland, Cal., 1,300; Ottawa, Ont., 1,560; Oxford, O., 1,000; Parkersburg, W. Va., 1,950; Peekskill, N. Y., 1,300; Philadelphia, Pa., 2,700; Pine Bluff, Ark., 1,300; Pittsfield, Mass., 2,?50; Pittsburgh, Pa., 26,450; Pittston, Pa., 1,200; Plainfield, N. J., 3 900; Plattsburg, N. Y., 1,500; Port Jervis, N. Y., 1,400; Portland, Ore., 3,000; Pottsville, Pa., 1,500; Providence, R. I., 7,500; Pueblo, Colo., 1,800; Richmond, Va., 6,950; Salem, N. J., 1,000; Salem, O., 2,050; San Francisco, Cal., 1,30?; Sandusky, O., 1,300; Saratoga, N. Y. 1,500; Savannah, Ga., 3,?50; Schenectady, N. Y., 4,1?0; Seattle, Wash., 1,5?0; Sheffield, Ala., 1,?00; Sing Sing, N, Y., 1,300; Sioux City, Ia., 1,400; Skaneateles, N. Y., 1,500; Springfield, Mass., 4,300; Springfield, O., 1,950; Stapleton, N. Y., 5,300; Sterling, Ill., 1,000; Steubenville, O., 2,250; St. Joseph, Mo., 3,750; St. Louis, 15,0?0; St. Paul, Minn., 4,100; Tampa, Fla., 1,150; Torrington Conn., 1,300; Trenton, N. J., 3,900; Troy, N. Y., 1,300; Tyrone, Pa., 1,700; Washington, Pa., 1,250; West Superior, Wis., 1,500; Wheeling, W. Va., 1,950; Wilmerding, Pa., 1,500; Williamsport, Pa., 2,250. This apparatus has been installed also in the following places outside of the United States and Canada: London, England, 25,000 lights; Canton, China, 1,500; Halifax, Nova Scotia, 1,400; Havana, Cuba, 1,500; Jui de Fora, Brazil, 1,500; Santa Anna, Salvador, C. A., 500; Sansonato, Salvador, C. A., 500; Shidsnoska, Japan, 1,500; Vancouver, B. C., 750.

APPLICATIONS OF POWER.

Normal, Ill., is to have an electric street railway.

Marlboro, Mass.—The poles are set for the extension of the electric street railroad.

Atchison, Kan.—The street horse car line is to be changed to the Sprague electric motor system.

Knoxville, Tenn.—The new electric street railway is now in active operation. It is four miles in length.

The Toledo, O., Electric Street Railway Company has increased its capital stock from $500,000 to $600,000.

Milwaukee, Wis.—There is talk of limiting the speed on the electric railways, now said to be too high for safety.

Thurmond, W. Va.—The Thurmond Coal Company is, it is stated, erecting a $20,000 electric coal mining plant.

The Duluth, Minn., Street Railway Company is trying to secure power for its electric motors from St. Paul, Minn.

Mexico.—The first electric motor car that ever entered the Mexican republic rolled over the Rio Grande bridge at Laredo, Tex., the other day.

Kansas City, Mo.—The Metropolitan Cable Car Company is already operating 40 miles of road, including the cable and the Thomson-Houston electric system.

Deptford, Tenn.—The Deptford Land and Improvement Company will, it is reported, construct an electric railroad. Wm. D. Kelley, Jr., president, can give information.

Augusta, Ga.—The contract has been let for the power house of the Electric Street Railway Company. It is said that this will be one of the best buildings of the kind in the country.

Port Townsend, Cal.—The city has granted a second franchise to build an electric street railroad. Contracts have been awarded, and the system must be in operation by Sept. 1.

Macon, Ga.—The newly organized Metropolitan Electric Railway Company has been granted the right of way, by the city council, through certain streets. Work on the road will commence at once.

Waterloo and Cedar Falls, Iowa.—Work has been begun on the new electric road connecting these two places, and it is expected that no very long time will elapse before the road will be in operation.

A Change of Motive Power.—Wm. Elsom, superintendent of the Marion and Cedar Rapids Railway, was in Chicago last week, arranging for electric power for his road, which is now operated by steam.

A Consolidation.—The three electric railroad franchises for Athol, Gardner and Greenfield, Mass., are now held by the same corporation, and it is probable that the three lines will be built simultaneously.

The Cincinnati, O., Electric Engine Company, 12 East Third street, are producing a motor that is unique in construction, and that gives very satisfactory results. They are doing a good business in this line.

A New Company.—It is said that the Electric Welding Syndicate, which is showing the Thomson process of electric welding in England, is about to launch a large company with a capital of £400,000, to work the system.

Dayton and Bellevue, located on the Kentucky side of the Ohio river, in the suburbs of Cincinnati, are to have an electric street railroad. The road will cross the river on the new bridge now being built, and will run to Fountain Square.

Kalamazoo, Mich.—Wayne Griswold, one of the trustees who purchased the Kalamazoo street railway, does not believe in overhead electric car service and thinks the storage system in a few years will be the only street car motive power.

New Orleans, La.—The Electric Traction and Manufacturing Company has entered into a contract with the Crescent City Railroad Company to run its cars by electric power. Ten cars have been supplied with motors and batteries, and work is progressing on twenty more. The cars are to be running by the first of June.

Troy, N. Y.—The electric railway company is now having a survey made for the road to Ballston, entirely east of the Delaware and Hudson tracks, thus avoiding the two crossings which would be required if the track followed the originally proposed route along Ballston avenue.

The Cincinnati, O., Street Railroad Company will build this summer an electric street railroad to connect the suburb known as Mount Lookout with the city. This road when completed promises to be one of the best equipped roads in the country. The total length will be about six miles.

Whitman and Abington, Mass.—The project of building an electric road between these two places, to run to Rockland and connect with the Weymouth line, is under consideration. In case it is carried out, Brockton will have direct electric road connection with all these towns when the Whitman line is completed.

Winona, Minn.—After several months' delay, the prospects for an electric motor line for this city have materialized to the extent of the arrival of ten motors—sufficient for five cars. The cars in present use will be altered to accommodate the machinery. Owing to the absence of Vice-President DeCelle, it is not certain what steps the company will take.

The Oshkosh (Wis.) Electric Light and Power Company has secured a franchise to establish an annex to its plant, for the transmission of power for motors. A large number of factories, using from 10 to 20 h. p. each, have signified their intention to avail themselves of this opportunity to curtail expenses by substituting electricity for steam power.

The Pittsburgh Traction Company, which operates the cable system between Pittsburgh and East Liberty, Penn., has just ordered two cars to be used on an electric feeder which has been recently constructed. The new cars will be placed on the line this week, and set to running immediately. The company, it is thought, intends to charge an extra five-cent fare on this electric feeder.

Rutland, Vt.—The new works of the Vermont School Seat Company will soon be under way. Ground has already been broken for the foundations. The plant is located south of the Howe Scale Company, on the Rutland Railroad. The company has just closed a three years' contract with the Rutland Electric Light Company, to furnish motive power to run the machinery of the new works.

Pittsburgh, Kan.—The Westinghouse Electric Railway Company is now building an electric railway here. Through the business portion of the city there will be a double track, with a single track for the suburbs. Materials for the track are on the ground, cars and machinery will be ready when the track is, a handsome station is to be erected, and the whole work will be energetically pushed to completion.

Worcester, Mass.—The work on the new electric railway line on Grafton street began on May 26, under the management of Messrs. T. W. Harris & Co., of Boston. The men, 24 in number, began the work at Elm square, and are working down the hill in charge of Foreman J. J. McCullough. The rails, which were made at Johnstown, Pa., have arrived, and will be laid as soon as possible. The electric system is nearly the same as in other cities.

Richmond, Va.—The City Council has given the Southside Land and Improvement Company permission to use electricity on that company's proposed railway on Seventh street. The arbitrators appointed for the purpose of fixing the amount to be paid the Richmond Union Passenger Railway by the Southside Land and Improvement Company for running its cars over the track of the former, have made their report, but the sum has not yet been made public.

Asking an Extension of Time.—The electric street railway of Richmond, Va., appealed to the city council, asking that the time when the poles on Main street shall be taken down unless all the cars are run by electricity, be extended from July 1 to August 1. The time asked was granted under a condition that a guaranty be made that all the cars shall be run by electricity at the time designated, accompanied by a bond of $5,000 for the faithful performance of the promise.

The Keith Electric Company, of San Francisco, Cal., has sold its business, patent rights, etc., to the Electrical Engineering Company, which has leased the building at 21 and 23 Spear street, and will establish a manufactory of electric power machinery. Prof. N. S. Keith is manager. The new company is understood to have the backing of certain capitalists who have long been identified with electrical interests on the Pacific coast.

Oakland, Cal.—A meeting of the directors of the Oakland & Berkeley Rapid Transit Company was held Monday, May 19, at which bids were received from the Sprague and the Thomson-Houston companies, for supplying motive power for the Grove street line. Bids were also received for the construction of cars, but the matter was taken under advisement and no contracts have yet been let. The work on the roadbed is progressing as rapidly as possible. No time has yet been set for the completion of the road.

The Fort Worth, Tex., Land and Street Railway Company are now operating 15 cars on 12 miles of road. There are 59 right angle curves in the track, and several grades rising in some places to 7½ degrees. The Rae overhead system is used, and, notwithstanding the difficulties to be overcome, it has given perfect satisfaction. When, at the time of the Palace Exposition, the city was crowded with strangers and the cars were in great demand, a motor and a trailer frequently carried successfully from 100 to 150 passengers over the hills.

Newburyport, Mass.—A big land purchase has just been made here by the Newburyport & Amesbury Street Railway Company, and a power plant is to be established for running the electric lines of the company in this section. The erection of a brick building 100 × 70 feet is to begin at once. It will be equipped with a new engine and two large dynamos. The purchase includes 25 acres, and on the space not used for power house will be erected paint, machine and repair shops. This improvement will necessitate the expenditure of about $100,000.

The Thomson-Houston Electric Company has recently finished the equipment of the following roads, on which the cars are regularly running: Georgetown & Tenalleytown (D. C.) Street Railway, 5 cars and six miles; Vancouver (B. C.) Electric Railway, 4 cars and 3½ miles; Union (N. Y.) Belt Line Railway, 25 cars and 20 miles; Milwaukee (Wis.) Cable Company, 12 cars and 15 miles; Knoxville (Tenn.) Street Railroad, 5 cars and 3½ miles; North Side Railway, Fort Worth, Tex., 15 cars and 15 miles; Attleboro (Vt.) & Wrentham Street Railway, 5 cars and 6.50 miles; the Albany (N. Y.) Railway, 32 cars and 14 miles.

Roanoke, Va.—A model of a new electric street car has been for some time on exhibition in the city. The power is furnished by a wire running along the centre track from the outside batteries and by a connection between the car and the centre wire. Messrs. R. H. Woodman, M. A. Rife, E. H. Stewart, B. L. Greida, S. W. Jamison, and a number of other capitalists are organizing a company with capital stock of $500,000 to control this patent and operate the cars in the different cities of the United States. They propose building a full-sized car to test the practical operations of the invention. If it proves successful Roanoke will have an electric street railway.

Pittsburg, Pa.—The Pittsburg & Allegheny Traction Company is considering the advisability of increasing its capital stock to $3,000 000. This company is at present running horse cars, and those in authority think that the time has arrived to adopt electricity as a motive power. The lines of this company are known as the Union Line, the Rebecca Street Line, the Western Avenue Line, and the Troy Hill Line. The Pittsburg terminus is at Market street, and a large part of the city of Allegheny is reached by the various lines. The change will necessitate large improvements on the Sixth street suspension bridge, between Pittsburg and Allegheny, over which the line runs.

Macon, Ga.—Mr. George F. Work, the well known Philadelphia capitalist, who owns about two-thirds of the electric light and street railway interests of this city, intends to make improvements in these properties to meet the public demand. There are only four motors on the Macon electric line, and some time since he gave an order for four new motors; but the increase of travel has caused the order to be increased to twelve. The line will be extended over the route originally mapped out when Mr. Work purchased the road, and the cars will soon be running over the dummy route to Vineville. A new fifty-horse dynamo has been ordered, and an order will be given at once for a new 200 h. p. engine to furnish electricity for the increased mileage.

The Shoshone Falls, Ind., Power & Electric Railway Company has been formed to construct and operate an electric railway line between the town of Shoshone, in Logan county, and Shoshone Falls, on Snake river; to utilize the water power of the falls for manufacturing, mining, milling and any other useful and beneficial purpose, and for transmitting electric power for railways and for light. The place where the principal business of the corporation is to be transacted will be at Shoshone, and the term for which the corporation is to exist is 50 years. The number of directors is seven. The amount of capital stock is $150,000, and the number of shares into which it is divided is 1,500. The amount of stock already subscribed is $25,000. The railroad is to be 25 miles long. The officers of the company named in the articles are: A. S. Senter, president, W. G. Lam, secretary, and C. S. Doan, treasurer.

Lynn, Mass.—The work on the new buildings of the Belt Line Electric road, at the junction of Eastern and Western avenues, is rapidly nearing completion. The power room is 50 ft. wide, 110 feet long and 20 feet high, and is covered with a truss roof. The engine and dynamo room is 50 by 60 feet, and contains a 200 h. p. Green engine with a fly wheel of 16 ft. diameter and 30-in. face. A 40-ft. shaft capable of transmitting 1,000 h.p. will cross the rear end of the building; two 80 h.p. electric generators will be put in at once, and eventually there will be six dynamos set up in the form of a half-moon. A 600 h. p. compound engine will also be added very soon; two 127 h. p. Abendroth & Root boilers have been set, and space is reserved for two more when needed. In the rear of the boilers are two large No. 6 Deane steam pumps for feeding the boilers, and also a Berryman heater for feed water. It is probable that by the middle of the present week the entire road will be open for passenger travel.

PERSONALS.

Frank J. Sprague has bought from Mrs. U. S. Grant, Jr., her house on Seventy third street and West End avenue, New York, for $70,000.

Mr. J. H. Munson, a graduate of the North Western University at Evanston, has become an active member of the National Engineering Bureau, of Chicago.

Mr. Fred C. Kelly, formerly connected with the Mather Electric Company, has been placed in entire charge of the outside construction work of the Cincinnati Electric Light Company.

General Manager G. H. Blaxter, of the Allegheny County Light Company, sails for England to-day, June 2. Mr. Blaxter looks forward to his trip with exceeding pleasure, as he expects to make a visit to the home of his childhood in Devonshire Co., England.

Mr. J. E. Powell, Superintendent of Electricity of the Treasury Department, Washington, is in Pittsburg, his errand being to look after the wiring of the new Government building. This building, by the way, has acquired a measure of fame from the fact that work was begun on it fifteen years ago. The end is not yet; but it is hoped the structure will be ready for occupancy next fall.

Mr. W. S. Ott, past president of the Omaha branch of the National Association of Stationary Engineers, has gone to Fort Worth, Tex., to take full charge of the construction of six electric light plants to be established by the Edison Electric Light Company. Mr. Ott was formerly engineer of the Thomson-Houston Electric Light Company's plant in Omaha, is a competent skilled engineer, and a gentleman who made hosts of friends during his residence in Omaha.

Mr. H. T. Paiste sailed last week on the "Teutonic" for a four months' business trip to Europe. The Paiste switch has met with such great demand from the other side of the water, that Mr. Paiste has found it necessary not only to make this extended trip, in order that he may personally interview his large number of patrons both in Europe and on the continent, but also to establish a branch factory in England; which latter is the principal object of the trip. The branch factory will be located at 11 Union Mews, Union street, London. Mr. Paiste has a host of friends among the electrical fraternity in this country, and we are certain that they will unite with THE ELECTRICAL WORLD in wishing for him a safe journey, a pleasant visit and a prosperous business trip.

MISCELLANEOUS NOTES.

Lynn, Mass.—It is estimated that 2,500 persons are now employed in the Thomson Houston Electric Works and the Thomson Welding Company's shop.

The Cincinnati, O., Branch of the Thomson-Houston Company, in addition to handling dynamos and motors, are carrying a complete line of electric light fixtures and supplies.

Bangor, Me.—Mr. M. H. Rideout, of this place, is negotiating for the sale of his patent electrical railway gauge to New York capitalists, who intend to secure European patents for the invention.

The Primary Battery Company, of Missouri, has been incorporated at East St. Louis, to deal in electrical inventions, with a capital stock of $500,000. The incorporators are: Frank Stillwell, W. M. Steele and E. A. Cheenery.

The Worrall Electric Construction Company has been incorporated at Chicago, to construct and maintain electric plants, with a capital stock of $500,000. The incorporators are: C. E. Gaylord, M. J. Frost and C. Y. White.

The Fitchburg, Mass., Steam Engine Company are running on full time, and report a large number of orders on hand. Their engines are being shipped to all parts of the world, and seem to give the satisfaction that their makers claim for them.

San Francisco, Cal.—W. S. Heger, district manager of the United Edison Manufacturing Company, has rented the building at 112 Bush street, three floors and a basement, and will have it fitted up for occupancy at once. He will put in a complete stock of dynamos and electrical supplies of all kinds.

Racine, Wis.—The City Council has passed an ordinance regulating the placing and maintaining of poles and other appliances used in transmission of electrical energy, and for inspecting inside as well as outside wiring. At a recent meeting the Council elected Prof. R. C. Hindley as city electrician for the ensuing year.

The Mechanics' Institute Fair, to be held this fall in San Francisco, will have a special department devoted to electrical appliances. It is said that this will be the finest exhibit of the kind ever seen on the Pacific coast. An effort will be made to secure the Edison exhibit that was used at the Paris exposition.

The United States Electric Company has been incorporated to handle electrical devices in Michigan and Ohio with a capital of $50,000. The stockholders are William E. Irish, of Brooklyn Village, O.; Robert S. West, John C. Hutchins and Thomas D. Owen, of Cleveland; and H. P. Davock and A. W. Beal, of Detroit.

The Ninth Annual Convention of the National Association of Stationary Engineers will be held in the city of New York during the first week of September, this year. There will be present the leading engineers from all sections of the country, who come to represent the various local associations in the national body, and it is to be hoped that the meeting will gather a large and active body of engineers, and will accomplish much good for an organization so worthy of continued success.

A Warning.—The morning breakfast bell at the Sagamore hotel in Lynn, Mass., a short time ago, was supplemented by a terrific explosion which brought the tardy guests from their rooms in hasty undress. An examination disclosed the fact that the explosion was caused by gas leaking from a broken pipe and filling the cellar and air spaces in the walls. Windows were broken in the hotel and adjoining buildings, and the laths and plaster of walls and ceilings in the first floor rooms were torn off and shattered.

The National Electric Light Association will publish in book form, early in July, the proceedings of the recent conventions held at Niagara Falls and Kansas City. They will comprise two volumes, which will be cloth-bound and got up in very attractive shape. It has been decided to accept a limited amount of appropriate advertising, and those wishing to be represented in this part of the work will do well to communicate with the Manufacturers' Advertising Bureau and Press Agency, 111 Liberty street, New York, who have the matter in charge.

BUSINESS NOTICES.

Thomas Day & Co. have taken the agency for the Pacific coast for the New York Insulated Wire Company.

Mr. A. L. Russell, the well-known manufacturer of electrical goods, is doing a big business in his finely equipped factory, Court street, Boston.

The Shultz Belting Company, of St. Louis, Mo., whose New England branch is 164 Summer street, Boston, is now doing a big business with its new style of leather-woven link belt. Several of these belts are now running in Boston.

Mr. Paul B. Chany, of the Novelty Electric Supply Company, 83 Coleman street, Cincinnati, O., has just returned from a trip east, and reports large sales of the company's electric street railroad specialties. The business of the company has developed to such proportions as to justify them in establishing an up-town office.

The Universal Arc Lamp Company, of New York, has appointed Mr. E. S. Mendels as its general agent, and all matters pertaining to the business of the company should be addressed to him at their office, 49 West Twenty-second street, New York City.

Battery Cut-Out.—Attention is called to a simple device for disconnecting gas lighting batteries if accidentally grounded. It is cheap, sensitive, never needs watching, and has no clockwork to be kept wound. Terms furnished by the Electric Supply Company of Syracuse, N. Y., No. 115 South Warren street.

The Lunkenheimer Brass Manufacturing Company, of Cincinnati, O., have issued a neat advertising catalogue, on which there is a patent pending. It is a very ingenious arrangement. The pages are punctured across the top, so as to be easily turn out and sent to the company for discount quotations, and the name and address of the sender written on a blank left at the bottom of the page for this purpose. This method saves letter-writing, avoids mistakes, and is at once to the point. It will be a convenience to those interested in these manufactures.

The Stilwell & Bierce Manufacturing Company, Dayton, O., have issued a large new catalogue of power transmitting machinery which well repays examination. It is a very complete list of gearings, pulleys and all sorts of apparatus for the transmission of power, especially hydraulic power, and contains a large amount of miscellaneous useful information, which will render it a convenience to engineers. The Stilwell & Bierce Company pay particular attention to keeping abreast of the times with the latest patterns in machinery, discarding everything antiquated and bringing out new patterns suited to every demand of modern engineering.

The New Process Raw Hide Company, of Syracuse, N. Y., are out with a small pamphlet containing a price list of their raw hide gears. Four weeks are required for the manufacture of these gears, but when finished they seem to work much more satisfatorily, as regards noiselessness, than those made of iron. Appended is a testimonial that speaks for itself:

GENTLEMEN: We have been using your raw hide gears on our electric motors for hoisting in the mines here. They do away with all disagreeable noise and are giving us perfect satisfaction. Some of the gears have been in constant use day and night for 15 months and are very little worn. The raw hide is not strengthened by metal in any manner. Yours truly,

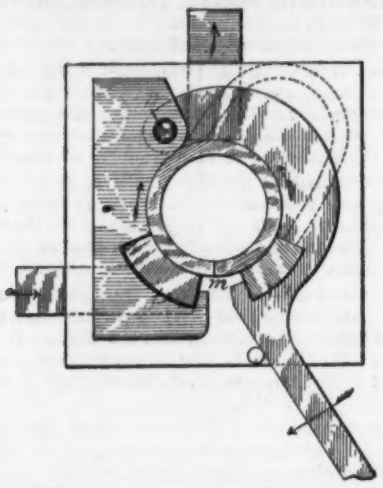
THE ROARING FORK ELECTRIC LIGHT AND POWER COMPANY,
C. E. DOOLITTLE, Supt.

OUR ILLUSTRATED RECORD OF ELECTRICAL PATENTS.

PATENTS ISSUED MAY 27, 1890.

428,586. Double Pole Switch; George H. Alton, of Lynn, Mass., Assignor to the Thomson-Houston Electric Company, of same place. Application filed Oct. 26, 1888. In a snap switch, the combination, with two cams of a switch lever arranged with its ends at the offset between the end of each cam and the beginning of the other, and a rotary propelling spring engaging with said cam surfaces, and a apted to engage directly with the lever as the spring leaves one cam to engage with the beginning of the other.

428,604. Process of Manufacturing Carbons; Charles Heisler, of St. Louis, Mo., Assignor to the United Gas Improvement Co., of Philadelphia, Pa. Application filed May 7, 1887. The



No. 428,617.—Apparatus for Welding Rings.

process of forming carbon pencils, consisting in pressing the ground and moistened carbons into short cylinders and in forcing the contents of the cylinders through a forming press, so as to obtain pencils of the proper diameter.

428,616. Sliding Clamp for Electric Welding; Hermand Lemp, of Lynn, Mass., Assignor to the Thomson-Houston Electric Welding Company, of Maine. Application filed Aug. 8, 1889. In an electric welding or metal-working apparatus, a slide supported on its rest or bed by a V-shaped bearing, said slide and bed being included in an electric circuit to the work, so that the electric current will pass through the bearing.

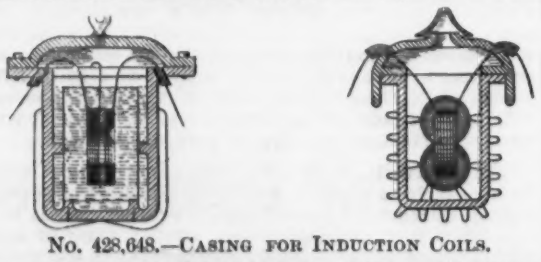
428,617. Electrical Apparatus for Welding Rings; Hermann Lemp, of Lynn, Mass., Assignor to the Thomson Electric Welding Company, of Maine. Application filed Oct. 17, 1889. In an electric metal-working apparatus, the combination of two clamps or clamping jaws having a conducting bearing on the outside of the curve of the ring or other curved object, and adapted to be moved toward one another on a line intersecting such curve.

428,619. Method of Welding Rings by Electricity; Hermann Lemp, of Lynn, Mass., Assignor to the Thomson Electric Welding Company, of Maine. Application filed Jan. 10, 1890. The method of welding rings or other curved metal objects, which consists in causing the electric current to pass through the continuous portion of the blank in amounts sufficient to soften the same, the molding or conforming such continuous portion to the curve required simultaneously with the welding operation.

428,620. Reactive Coil; Hermann Lemp and Walter S. Moody, of Lynn, Mass., Assignor to the Thomson-Houston Electric Welding Company, of Maine. Application filed Feb. 7, 1890. In an alternative current motive or regulating device having two coils or conductors adjustable over one another, a magnetic circuit of iron for the coils, the poles or ends of which iron circuit are located in proximity to one another, but are separated to a sufficient extent to permit the coils to be slipped upon the iron through the gap.

428,633. Method of Measuring Electric Currents; Edwin Wilbur Rice, Jr., of Lynn, Mass. Application filed March 8, 1889. The invention consists in alternately two heating expansible rods, bars or pieces of solid material by the agency of an electric current flowing alternately in two circuits or branches of a circuit, automatically switching the current from one branch to the other by the movement of the expansible rods, bars or pieces, as they alternately heat and cool, and registering and counting the number of movements of expansion and contraction of the rods, bars and pieces.

(1) 428,647. Turn-Off for Alternating Current Circuits; (2) 428,648. Casing for Induction Coils; (3) 428,649. Electric Meter; (4) 428,650. Alternating Current Magnetic Device; (5) 428,651. System of Electrical Distribution; (6) 428,653. Guard Wire Protector and Lightning Arrester for Electric Railways; Elihu Thomson, of Lynn, Mass. Applications filed (1) March 12, 1887; (2) May 9, 1887; (3) January 27, 1888; (4) August 8, 1888; (5) August 15, 1888; (6) June 15, 1889; (1) The invention consists in the combination, with the translating device operated by alternating electric currents, of a reactive coil or counter electro motive force generator and an electric switch suitably constructed to throw the generator into or out of circuit with the translating device, thereby changing the effective current through the same, and adapted at its opposite extremes of movement. (2) The combination with an electro magnetic coil, of a casing formed of a metal that is a good conductor of heat containing oil in a free intermediate space adapted to allow convective currents in the oil for conveying the heat of the coil to the casing. (3) A compound electric meter having two parts, one of which is constantly in action while the current flows, while the other is combined with clutch or gear mechanism for causing its indications to be added to those of the first upon an increase of



No. 428,648.—Casing for Induction Coils.

current in a predetermined amount. (4) The combination, with ban alternating current inductor, of an induction modifier or retarder located to one side of the general magnetic axis, and serving to produce a compound field of alternating induction whose parts differ or are displaced in phase. (6) The invention consists in the combination, with the aerial power line, of a guard wire or conductor suspended parallel to the same and provided at intervals along the aerial power line with branch connections to the earth or return wire, such branch connections being devoid of artificial resistances, so as to form a low resistance connection.

428,652. Incandescent Lamp Socket; Elihu Thomson and George H. Alton, of Lynn, Mass., Assignors to the Thomson-Houston Electric Co., of Conn. Application filed Jan. 17, 1889. In an electric lamp support, the combination, with the intermediate metallic frame, made in one piece, of the two attached insulating pieces, a contact terminal mounted upon the upper block and having a spring forming a switch spring, a switch spring mounted on the other block and in connection with the frame, and an intermediate rotary connecting piece rotable between the springs into and out of connection with the same, and borne by a horizontal spindle, mounted in the upright or standard of the frame.

428,669. Electric Locomotive; Edward Dummer, of Newton, Mass. Application filed Feb. 17, 1887. The invention consists in an electric locomotive so constructed as to embody one or more field magnets connected with the driving wheel or wheels to revolve therewith, while each field magnet may be magnetized constantly in one and the same sense, and thus be supported as one body with the wheel or wheels directly by the rails of a railway.

428,676. Electric Circuit Closer for Clocks; Henry C. Karr, of Washington, D. C. Application filed Feb. 14, 1889. The combination, with a flexible contact for closing the secondary circuit, a switch adapted to close the primary circuit through the medium of said contact, and a pin projecting laterally from the switch of the seconds-arbor, an arm on the arbor and a pin on the arm adapted to strike the pin on the switch and operate the latter.

428,684. Method of Preparing Battery Zincs; James H. Mason, of Brooklyn, N. Y. Application filed Feb. 6, 1889. The method of preparing battery zincs, which consists in first heating the zincs and then immersing it in an amalgamating solution composed of mercury and acid, whereby the zinc is thoroughly amalgamated

428,688. Electric Low Water Alarm; John Morehead, of Detroit, Mich. Application filed June 11, 1889. In combination, a water chain attachable to a boiler, a float in the chamber, a tube extending through the float and secured thereto, an electrical conductor led through the case of the chamber and through the tube and insulated from both the case and the tube, a second electrical conductor led through the case and insulated therefrom, the arrangement being such that the descent of the float will close the circuit between the conductors.

428,698. Single Cord Multiple Switch Board System; Charles E. Scribner, of Chicago, Ill., Assignor to the Western Electric Co., of same place Application filed June 1, 1888. In a single cord switch board system, the combination with a grounding spring jack and its plug with which it is operated, of a listening key and circuits connecting them together and with a telephone outfit, contact points of the grounding spring jack and the key being connected with the circuits to connect the telephone to the plug automatically when said plug is lifted, and to disconnect the telephone from the plug when the listening key is operated.

428,704. Electric Switch; (2) 428,705. Regulator for Dynamo Electric Machines; Elihu Thomson, of Lynn, Mass. Applications filed (1) July 26, 1886; (2) August 27, 1887. (1) The invention consists in a pivoted arm mounted upon a suitable base bearing one or more contacts, the arm being made of conducting material and provided with a spring so arranged as to hold the switch open when desired or hold the operating

No. 428,742.—Commutator Collector.

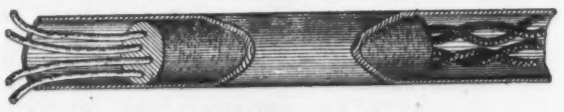
arm upon the dead center when the switch is closed. (2) The combination, with the adjustable commutator for a dynamo machine, of a rotary electric motor having a constant torque for a given current traversing its coils, and driven by the current from the machine, and a counteracting or retracting device of constant effect in the various positions of adjustment.

428,735. Brush Holder for Dynamo Electric Machines; Franklin A. Weller, of Lynn, Mass. Application filed Aug. 29, 1889. In an electric brush holder, the arm of the rod and its support, said arm or rod having an angular or bent portion provided with a head or disc in combination with the brush holder, with a brush and follower, and the holding an adjusting screw therefor.

428,742. Commutator Collector or Block for Dynamo Electric Machines; Charles F. Brush, of Cleveland, O. Application filed Nov. 22, 1889. A commutator current collector or block consisting of carbon and interspersed metal.

488,743. Commutator Collector or Block for Dynamo Electric Machines; Charles F. Brush, of Cleveland, O. Application filed Nov. 22, 1889. A commutator current collector or block consisting of graphite combined with interspersed metal of good electrical conductivity.

428,745. Electric Cable; Willard L. Candee, of Brooklyn, Assignor to the Okonite Company, of New York, N. Y. Application filed March 19, 1890. An electric cable composed of a con-



No. 428,745.—Electric Cable.

ductor or group of conductors individually insulated except at the ends by a braid or wrapping of fibrous material, and an impermeable sheath or covering, the terminals of the conductors being covered by and imbedded in a waterproof insulating compound which fills and closes the end of the sheath or covering.

428,746. Galvanometer; Arthur E. Colgate, of New York, N. Y. Assignor to F. G. Otto & Sons, of same place. Application filed March 1890, The invention consists in the combination of a balanced needle with a core wound with two wires, one coarse and the other fine, the coarse wire connecting with a battery and with an induction coil, the fine wire connecting with the battery and the hammer posts of the induction coil.

428,748. Device for Maintaining Electrical Connection between Separate Railway Trains; Donophan M. Fike and Joseph Huffman, of Des Moines, Ia., Assignors of three-fifths to J. A. T. Hull, R. B. Taylor, E. J. Fairall, R. M. Dewitt, W. W. Fink and A. J. Baker, of same place. Application filed Feb. 14, 1890. The invention consists in the construction and combination of a flexible electric conductor with a car and instrument for transmitting messages in such a manner that the conductor will adjust itself vertically and horizontally as required to retain it in contact with the wire supported by poles at the side of a track.

428,774. Burglar Alarm; Edward Halward, of Brooklyn, and Edward S. Sims, of New York, N. Y. Application filed Aug. 9, 1889. The combination, with a lock adapted to be mounted upon a door and comprising a metallic case and a bolt adapted to be thrown when the door is closed, of a battery, an electric signal, circuit wires including said battery and signal, a contact piece upon the interior of the case, and an insulated metallic piece extending through the case, to the inner end of which the contact piece is secured, and to the outer end of which the circuit wires are secured, the other of said circuit wires being connected directly to said metallic case.

428,781. Galvanic Battery; John S. Nowotny, of Cincinnati, O., Assignor of one-half to James J. Watrous, of same place. Application filed Nov. 2, 1889. A battery cell composed of carbon and provided with interior partition or partitions of carbon integral with the sides of the cell.

428,782. Electric Motor, or Dynamo Electric Machine; Stephen Merritt Potter and Harry Ernest Morgan, of Philadelphia, Pa. Application filed June 27, 1889. The combination, with the field magnet armature, and end casing, enclosing the field magnets and armature, of a commutator connected with the armature, an adjustable bar located within the casing, commutator brushes mounted upon the adjustable bar, and a device connected with the adjustable bar and extending through the end casing for imparting adjustment to the bar and brushes.

428,888. Solution for Galvanic Batteries; Edward Milton Curt, of Paris, Ill. Application filed March 10, 1890. In a galvanic battery an exciting solution formed of the soluble salts of burned Indian corn cobs, the same consisting of carbonate, phosphate, silicate, and chloride of sodium, potassium, iron, calcium and magnesium.

428,900. Register for Gas Meters; Leo Ehrich, of St. Louis, Mo. Application filed Nov. 22, 1888. A gas meter having a rotary shaft which controls the indicating frame, provided within its case with an insulated disc, having metallic contact portions and insulated conductor bearing upon the said disc, and extending through the meter case, in combination with an electric circuit having one terminal include the said insulated conductor and the other the metallic contact portion of the said disc and electro magnetic register in the said circuit distant from the meter.

428,917. Electrically Propelled Vehicle; Arnold A. Ingraham, of New York, N. Y. Application filed Aug. 16, 1889. The combination, with the brake mechanism in a car, of a circuit-closing switch, a lever arm, and a spring intervening between the same and the circuit-closing strip for moving the switch suddenly in one direction or the other, a connection between the lever arm and the brake mechanism, and a turnbuckle or adjusting mechanism for regulating the action of the electric switch in its relation to the brake mechanism.

428,930. Suspension for Trolley Wires; Elmer P. Morris, of Cincinnati, O. Application filed Jan. 6, 1890. The combination in suspensions for trolley lines, having inclosing case, a wire-

No. 429,033.—Watch Demagnetizer.

carrying car suspended therefrom, an insulating spool mounted in the inclosing case.

428,934. Electric Switch; James F. McLaughlin, of Philadelphia, Pa. Application filed Nov. 13, 1889. In an electrical switch, the combination, of a rotary winged switch block, each wing having one cam and one convex cylindrical contact surface meeting at an obtuse angle, the spring actuated contact levers within the sweep of cam surfaces of the block.

428,935. Electric Switch; James F. McLaughlin, of Philadelphia, Pa. Application filed Nov. 27, 1889. In an electric switch, the combination, with a rotary switch block operating in conjunction with suitable contact brushes, of a trigger for locking the block in its closed position, an electro-magnet for moving the trigger to unlock the switch-block and a spring for automatically opening the switch when the block is unlocked.

428,942. Holder for Electric Arc Lamps; James Pawlowski, of Cincinnati, O. Application filed Sept. 7, 1889. In a holder for electric arc lamps, the combination of a board, binding posts or holders for the circuit wires, which pass from said holders to the lamp secured at opposite ends of the board, and a lamp holding arm secured at one end to one of the circuit wire holders, extending over and normally pressed against the opposite wire holder, and adapted to be drawn from the holder by the weight of the lamp, whereby the circuit is maintained should the lamp be dislodged.

428,970. System of Circuits for Electric Semaphores; Frederick Stitzel, of Louisville, Ky., Assignor to the American Semaphore Co., of same place. Application filed February 16, 1889. The combination, with a block of railroad and a semaphore at each end thereof of normally closed electrical circuits, including the rails of the track, conducting wires, and the main semaphore magnets of both semaphores, a second normally open circuit, including a second set of semaphore magnets, and devices for holding said second circuit normally open and automatically closing it.

428,979. Electric Insulator; George B. Watson, of Boston, Mass., Assignor to the Gould & Watson Company, of same place. Application filed August 12, 1889. An insulator comprising a block having an enlarged end and beveled sides, a collar having a tapering or beveled aperture, a cap secured to the collar, and an interposed layer or mass of insulating material separating the block from the collar and cap.

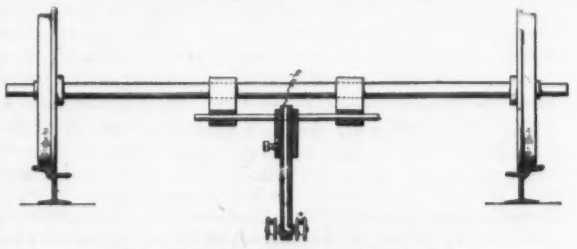
429,012. Magnetic Tool; Charles F. Carpenter, of Louisville, Ky. Application filed Aug. 17, 1889. An electro-magnetic cutting instrument having an electro magnet, a central-acting non-magnetic hammer rod within the core of the electro magnet, an axial anvil piece or bit-carrier, retracting springs, short circuiting devices and a cut-off.

429,033. Watch Demagnetizer; Ferdinand F. Ide, of Peoria, Ill. Application filed January 30, 1890 The demagnetizing device for watches, which consists of a horse shoe shaped magnet secured together at their curved portions and to a central spindle or axis and arranged radially to said spindle or axis, and supporting bracket, which forms bearings for said spindle and has its lower arm under the poles of said magnet, and preferably smooth upon its lower surface.

429,058. Device for Suspending Electric Conductors; Homer Irving Pierce, of Lynn, Assignor of one-half to Harry L. Pierce, of Leominster, Mass Application filed Jan. 28, 1890. In a supporting device for electrical conductors, the combination, with an arched frame, grooved to receive the electrical conductor, of the U-shaped clasp having a thickened central portion to correspond with the arched portion of the frame.

429,068. Male Genital Electrode; Agnes R. Somerville, of Chicago, Ill. Application filed December 19, 1889. A male genital electrode composed of a cup, and a projecting part attached thereto, combined with a cover hinged to the projecting part by means of hinges at both its side edges.

429,074. Staff Apparatus for Controlling Traffic on Single Line Railways; Francis W. Webb and Arthur Moore Thompson, of Crewe, County of Chester, England. Application filed Jan. 24, 1890. Patented in England, Jan. 23, 1889; in France, May 20, 1889; and in Belgium, May 20, 1889. In a staff system for controlling the traffic on single line railroads, a holder provided with a passage for the introduction and removal of a staff, and a lock adapted to obstruct the passage of a staff to and from the holder, in combination with a staff constructed and



No. 429,093.—Electric Railway.

adapted to operate the lock to clear the passage to or from the holder.

429,093. Electric Railway; Rudolph M. Hunter, of Philadelphia, Pa., Assignor to the Thomson Houston Electric Company, of Connecticut. Application filed Sept. 11, 1889. The object of the invention is to supply current to electrically propelled vehicles from one or more suspended conductors extended along a railway, be they elevated above the vehicle, on a level with the roof of the vehicle or under the vehicle.

429,094. Electric Motor, Rudolph M. Hunter, of Philadelphia, Pa., Assignor to the Thomson-Houston Electric Company, of Connecticut. Application filed Nov. 8, 1889. The invention has reference to alternating motors, and it consists of certain improvements in which alternating currents, or those of alternately increasing and decreasing potential, are employed as the energizing medium.

429,104. Underground Conduit for Electric Wire; Erich L. Witthaus, of Baltimore, Md. Application filed Jan. 29, 1890. An electric conduit comprising a casing of wood saturated in lubricating oil, a filling of sawdust and rosin within the casing, and insulation around the wire within the filling.

Copies of the specifications and drawings complete of any of the patents mentioned in this record—or of any other patents issued since 1866—can be had for 25 cents. Give date and number, and address The W. J. Johnston Co. Ltd., Times Building, N. Y.

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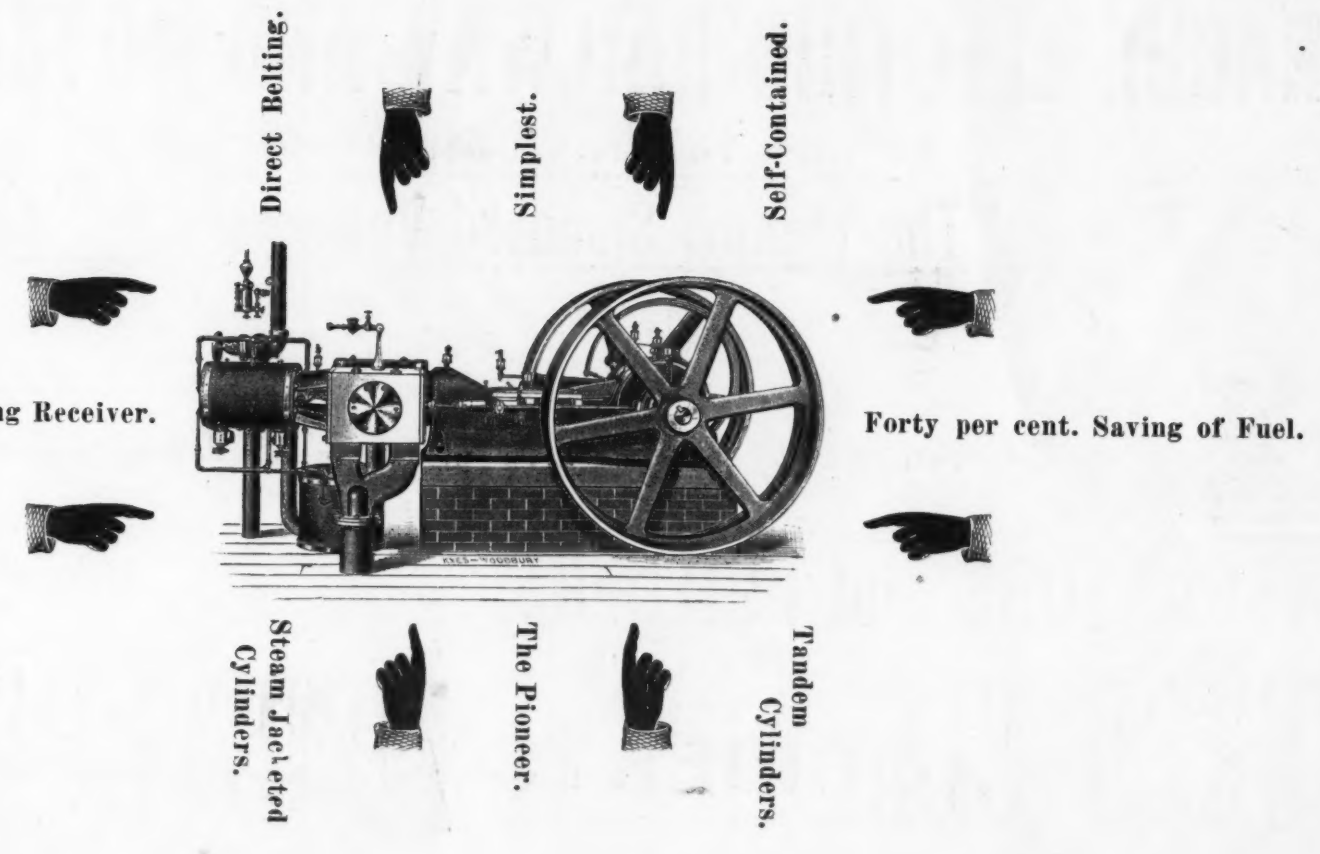

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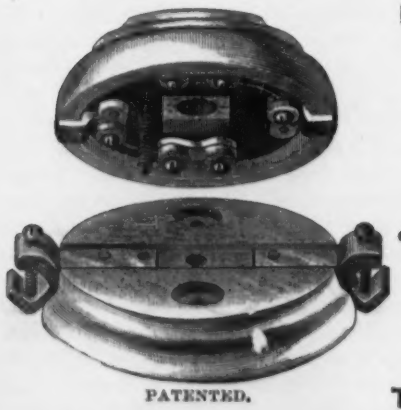

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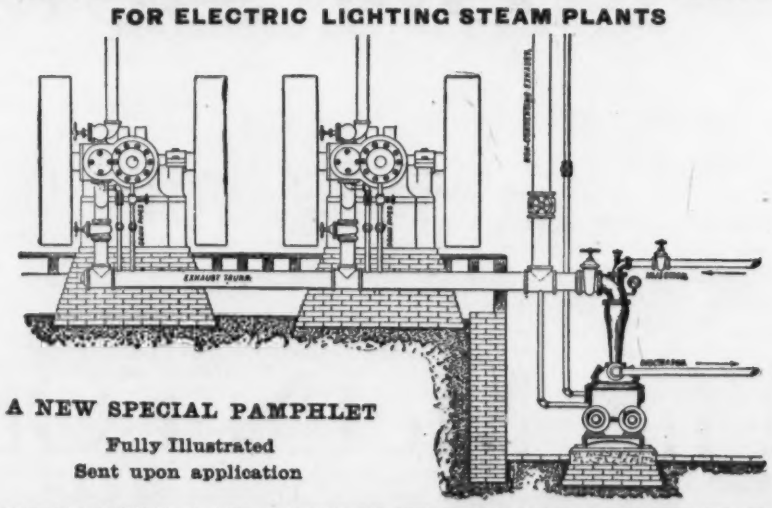

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